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ABSTRACT

A study was conducted to determine if the centralization of playback machine operations for the national free library program would be feasible, economical, and desirable. An alternative model of playback machine services was constructed and compared with existing network operations considering both cost and service. The alternative model was centralized machine storage, repair, and distribution operations. This report presents the findings of the study in three sections. Section 1 presents a summary of the first phase of operations and the study objective for phase two. Section 2 identifies several criteria that are important to the network's distribution (e.g., minimization of delivery time of machines to patrons, labor costs, and occupancy costs); presents a profile of the network, estimates of delivery time, and calculations of the centroid or "center gravity" of the recorded book readership to be close to St. Louis, Missouri; presents one, two, and more than two central distribution centers scenarios; examines prevailing labor and occupancy costs; and describes the best configuration for central distribution. Section 3 presents macro-level operating procedures, workload requirements, resource requirements, and estimated costs for centralized machine operations. The discussion in this section focuses on workload requirements (readership to be served, repairs to be performed, circulation to be generated, inventory to be stored); operating procedures; labor requirements and estimated costs; estimated occupancy requirements and costs (facility space required for machine storage and other than machine storage, total estimated occupancy requirements and costs); and all other requirements and estimated costs. It was concluded that, although the estimated operating costs indicate that both of two scenarios for centralized machine operations would be more expensive than the current system, the national library service should not discard the concept of machine operation centralization, and four reasons are given for this recommendation. An executive summary is provided, and 25 appended tables, charts, and maps provide statistical profiles related to these issues. (MAB)

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PHASE II REPORT
VOLUME II

ALTERNATIVE MODELS OF SERVICE, CENTRALIZED MACHINE OPERATIONS

to:

National Library Service for the Blind and Physically Handicapped Library of Congress

for:

Data Collection Services

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EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

The National Library Service for the Blind and Physically Handicapped (NLS), The Library of Congress, commissioned Technology Management Corporation (TMC) to construct an alternative model of playback machine services provided to patrons of the national free library program, and to compare it with existing network operations considering both cost and service. This alternative model was centralized machine storage, repair and distribution operations.

The development of an alternative model of operations focused exclusively upon network operations, and excluded consideration of costs directly incurred by the United State Postal Service, which provides transport of materials for the program, and the acquisition costs directly incurred by NLS for playback machines, machine repair parts and associated supplies for machines; these costs and operations were outside the scope of the study. Also outside the scope of the study were the methods by which centralized operations, if implemented, would be funded. Finally, the development of an alternative model of centralized operations was a feasibility study, not an implementation study, and as such *detailed* recommendations pertaining to operating procedures, facility configuration, capital equipment requirements and staff composition were *not* developed; however, macro-level requirements and costs for all applicable areas were developed.

An analysis was first performed to determine the best distribution network for centralized machine operations, the primary criterion being the minimization of delivery time to patrons, the secondary criterion being the minimization of labor costs, the tertiary criterion being the minimization of occupancy costs, and an additional, subsidiary consideration of weather conditions to the extent that centralized operations and/or postal deliveries would be impacted. A mathematical profile of the network was developed modeling the geographic distribution of network demand for playback machines using recorded book readership as a weighting factor for the geometric model. Potential locations for machine distribution centers were constrained to the 29 metropolitan areas in which the United States Postal Service has bulk mail facilities, the logic being to facilitate distribution center output entering the bulk mail stream on the same day that orders are picked. A delivery time estimation equation was derived from USPS service standards to model delivery time from various potential supply points to demand points in the network.

It was determined that the machine user centroid, or "center of gravity," lies in south-central Illinois. The theoretical location that would minimize average national delivery time for machines

was found to lie in south-east Indiana. Knowing both of these locations, it was determined that if a one-center operation were to be established, with the sole location criterion being minimization of delivery time to patrons, then the choice would be reduced to Cincinnati, Ohio; Chicago, Illinois, or; St. Louis, Missouri. However, a one-center operation for machines is absolutely not recommended for risk diversification reasons, i.e., if a catastrophe should occur at a single center facility, the entire national inventory of machines, not in the possession of patrons or in-transit, would be destroyed. Additionally, the maximum delivery time to some regions of the country would be too long to make a one-center operation feasible.

An analysis was then performed for a two-center operation using OPTISITE, a site location optimization computer program, with the selection criterion still being only minimization of average national delivery time. The results of this analysis yielded the most desirable two locations for centers serving eastern and western regions of the country. Denver, Colorado and Salt Lake City, Utah are the best locations for western centers, and Pittsburgh, Pennsylvania and Cincinnati, Ohio are the best locations for eastern centers. Due to the national distribution of demand for machines, the eastern center would be considerably larger (63%), in terms of users served, than the western center (37%), under operating schemes that minimize average national delivery time. An analysis of the prevailing costs of labor, the prevailing costs of facility space, and the prevailing weather conditions at all four of the sites mentioned above yielded the conclusion that Salt Lake City and Cincinnati would be the optimal locations for situating machine central distribution centers. An analysis of a three-center operation was also conducted, but it was determined that the marginal improvements in average and maximum delivery times were more than offset by reduced efficiencies from increasing decentralization. Additionally, the optimal sites (based on delivery times) selected under the three-center scenario were New York, St. Louis, and San Francisco and both New York and San Francisco have highly unfavorable prevailing labor and facility space costs.

Centralized machine operations would consist of a western center situated in Salt Lake City, serving 37% of national recorded book readership (all states west of the Mississippi River), and an eastern center situated in Cincinnati, serving 63% of national recorded book readership (all states east of the Mississippi River). The inventories of both TBMs and CBMs to be managed by each center would be in proportion to the readership served. The analysis of machine repair parts operations were outside the scope of this study, so it was therefore assumed that the current *modus operandi* would continue after implementation of centralized operations, i.e., that NLS would procure, store and

distribute repair parts as required to the machine centers (however, there is no compelling reason why the repair operations at the centers, if performed in-house, could not assume this function).

The machine centers would act as service points for network libraries and agencies, with the only direct interaction between the centers and patrons being the issues and returns of the machines themselves, except for machine center participation in contacting patrons concerning the return of overdue machines. Network libraries would retain the responsibility for registering patrons with the service and updating patron records, and for providing all necessary advisory services and placing machine issue orders with the centers. The centers would be responsible for all storage, distribution, inventory management and repair functions, and would have the primary responsibility for contacting patrons for overdue machines. Such a *modus operandi* would require a telecommunications link between network libraries and the centers, and shared databases that network libraries could not only query, but also modify.

It is recommended that input and output functions be expedited by use of wanding and/or scanning of OCR and/or bar coded machines; this would also enhance the inventory management function. Shelf rack storage to a height of 8' is recommended for both TBMs and CBMs. The western center would require approximately 21,600 sf and the eastern center 36,800 sf for all operations. Machine repairs would either be performed by an in-house staff of electrical technicians, or by a contractor; both scenarios were modeled, and it was assumed that contractor repairs would be performed on-site.

Conclusions regarding the economy, feasibility and desirability of centralized machine operations are not "clear-cut." There are several reasons for this situation.

Based upon the cost analyses performed in this study, it appears on face value that machine centralization is not economical. The total estimated annual costs for each of the two operating schemes, i.e., in-house and contracted repairs, based upon FY1989 workload, are $8,845,000 for the in-house repair scenario, and $9,044,000 for the contractor repair scenario. In comparison with total current network costs for machine operations, which was estimated in Phase I of the study to be $7,816,000 per year, these alternative scenarios would be $1,029,000, or 13%, and $1,228,000, or 16%, more expensive than current operations, respectively. The primary reason for the increase in total costs are increases in labor costs (paid staff rather than volunteers performing repairs), because

there would be a significant decrease in occupancy costs under centralization (54% reduction), and all "other" costs would be approximately the same as is true for existing operations.

However, TMC nevertheless recommends that NLS *not* discard the concept of machine operations centralization outright solely on the basis of this cost analysis. There are four reasons for this recommendation: (1) Based upon the repair cost behavior of several visited sites that use paid staff, the repair time estimates used in the analysis (given to TMC by NLS) *may* be overly conservative, possibly by as much as 34% - projected labor costs associated with machine repairs may, therefore, be $1.1 million high; (2) In the future, more complex and sophisticated machines will replace the current inventory of playback machines - repair of these machines will require expensive diagnostic equipment which will make repair on a decentralized basis infeasible; (3) Contractors evidently have a greater propensity to consume repair parts than do volunteers or paid staff for machine repairs, if this is indeed the situation, the case for using in-house staff for repairs rather than contractors is strengthened, and; (4) Centralization of the inventory management function would improve controllability of the national supply of machines, and could potentially reduce required production of machines, other things being equal.

Regarding the feasibility and desirability of machine centralization, TMC believes that centralization is feasible, but the envisioned operating scheme is complicated, and its efficiency would be reduced, by allowing a *modus operandi* whereby network libraries would be permitted to house "depository collections" of machines. These secondary supply points would complicate the inventory management function. The only instance wherein machine depository collections are necessary, and recommended, are at the five (4 RL, 1 SRL) geographic outlier sites.

TMC concludes that NLS should at least perform an implementation study for machine centralization, despite some of the complications cited in this report. In all likelihood, the repair function will probably eventually have to be centralized, and because the inventory of machines needing repair accounts for half of on-hand inventory, the logical extrapolation of this is to also house the machines available for assignment in centralized locations as well, where the occupancy costs are dramatically lower than in network libraries. An additional reason for centralization of machine operations is that the free library program is a *national* program, the quality of machine services currently varies considerably among network sites, and a centralization scheme would result in a more uniform quality of service being offered to patrons.

Section 1

INTRODUCTION

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1.1 BACKGROUND

The National Library Service for the Blind and Physically Handicapped (NLS), Library of Congress, administers a free national library program for persons who are unable to read standard printed materials due to physical or visual impairments. In cooperation with authors and publishers of books and magazines, NLS is granted permission to mass-produce copyrighted works. NLS works with a network of state, local and private libraries and agencies, which provides the necessary resources for the storage and distribution of the NLS materials. The books and magazines in braille, recorded disc and recorded cassette format, as well as specially designed playback machines and accessories, are delivered to eligible patrons by postage-free mail, and returned to network libraries and agencies in the same manner.

The free national library program consists of three major components, each with its associated responsibilities, costs and revenue sources. NLS, funded by Congress, secures copyright permission from authors and publishers, contracts with firms for the mass production of braille and recorded books and magazines, machines, accessories, and repair parts, and administers the program. The United States Postal Service (USPS), funded by Congress for this program, provides transport of program materials between and among network facilities, patrons, NLS, and points of book and machine manufacture and repair. The network, consisting of state, local and private libraries and agencies, funded by various combinations of federal, state, local and private sources, provides the personnel, facilities and other resources necessary to provide NLS materials to patrons.

There were four basic types of facilities in the network during federal fiscal year 1989. Regional libraries (RL), of which there were 56, provide a comprehensive range of services, including services in addition to distributing NLS sponsored materials. Subregional libraries (SRL), of which there were 92, provide service to a specified part of a regional library's territory. Machine lending agencies (MLA), of which there were 8, control and distribute NLS machines and accessories to patrons in a specified service area. Multistate centers (MSC), of which there were 3, are NLS agencies that distribute program materials and backup supplies to network libraries and agencies, as well as braille and recorded books from special collections directly to patrons.

1.2 SUMMARY OF PHASE I

In Phase I of the study, Technology Management Corporation (TMC) determined the baseline costs of operations for the network of libraries and agencies that provides braille book services, recorded book services, and playback machine loan services to patrons of the national free library program. In addition to the determination of baseline costs for network operations, a 15-year projection of these costs was also performed.

TMC initially compiled a statistical profile of the network and made a pilot site visit to the Washington, D.C., regional library. With the guidance and approval of NLS staff and an advisory committee composed of network administrators and other interested parties, a data collection plan was formulated, and a representative sample of network sites was selected whose cost behavior was used to model the baseline costs of the entire network population. The data collection plan was designed to capture all relevant costs of operations, including costs associated with labor, facility occupancy, capital equipment depreciation, equipment maintenance, services, supplies, miscellaneous activities and administrative overhead. The sample was designed to include sites which spanned the full range of size for readership, circulation, collection and several other operational attributes, as well as full geographic representation. A total of 35 sites was selected for the sample: 17 regional libraries, 15 subregional libraries and all 3 MSCs.

Study teams consisting of one or two individuals made visits to each selected site for a period of approximately one week for the purpose of data collection, which involved the collection of raw financial and operational data, the interviewing of staff to determine time spent on particular activities, the assessment of facility space and capital equipment utilization, and the determination of the uses of all other resources. The data thus collected was then analyzed and compiled by cost category, e.g., labor, and by operation, e.g., braille book services, taking into account all direct and indirect costs incurred by the sites themselves or any parent or administering organizations that support the operations under study. Costs directly incurred for the provision of specific operations were assigned directly to those operations, while indirect costs were allocated to applicable operations by the most appropriate allocation bases. It was readily apparent at the conclusion of these individual site analyses that labor was the most significant cost category, followed by occupancy costs, and then all other costs.

The projection of baseline network costs was then performed, based upon the cost behavior of the sample sites, operational statistics as reported to NLS by network libraries and agencies, and unit occupancy costs compiled by the General Services Administration (GSA). Independent mathematical relationships relating the costs for the sample sites to their associated operational statistics were developed for regional and subregional libraries for each of the three operations under study, and for three major cost categories; labor, occupancy and all other costs. These cost prediction models assumed the form of both regression equations and step-functions of stratified means, which were then used to predict the costs of sites not visited based upon their reported operational statistics. In the case of occupancy costs, the cost prediction models first determined predicted facility space area (in square feet) and then applied the GSA RENT system unit occupancy costs to determine the full occupancy costs for each operation. For the MSCs, no cost predictions of the population from a sample was necessary because all sites had been visited and analyzed.

TMC found that the approximate costs of network operations for federal fiscal year 1989 (FY89) were $3,154,000 for braille book services, $7,724,000 for playback machine services, $30,181,000 for recorded book services, for a total of $41,058,000 for all three services combined. These figures represent the total expenses incurred by state, local and private libraries and agencies in the network, but exclude both the costs of all books, machines and other materials purchased for the program by NLS, and the costs of all postage-free mailings provided for the program by the United States Postal Service. These costs include all expenses for resources that directly or indirectly support the subject operations, regardless of funding sources, whether directly paid for by the network libraries and agencies, or paid for by parent or administering organizations. In addition to the costs incurred by state, local and private libraries and agencies for network operations in FY89, NLS directly incurred approximately $805,000 in costs for its multistate center operations of which $173,000 was for braille book services, $92,000 was for machine services, $387,000 was for recorded book services, and $153,000 was for publication and back-up supply services. Appendix 1 contains a tabular summary of these baseline costs, further stratified by the three major cost categories.

A 15-year projection of network costs for the three NLS sponsored operations was then performed based upon the baseline costs for the network as determined by the various cost prediction models, NLS estimates of future national readership growth rates, and cost inflation estimates as derived from economic literature. A 2% average annual net growth rate in number of patrons was assumed for recorded books and machines, a 1% average annual net growth rate was assumed for braille books, and a 3.5% average annual cost inflation rate was assumed for all three major

categories of costs that were modeled. Appendix 2 contains the 15-year projection for the combined network and MSC costs of operations for machine services, stratified by cost category.

1.3 PHASE II STUDY OBJECTIVE

The objective of Phase II of the study was to construct two separate alternative models of braille and machine operations for the free national library program, and compare them with existing network operations considering both cost and service. Specifically, these two alternative models are:

(1) Centralized braille storage and distribution operations; and

(2) Centralized machine storage, repair and distribution operations.

The functions that are currently performed and the costs that are incurred by the existing network of libraries, agencies and MSCs for braille and machine operations are detailed in the Phase I, Volume I and II reports, and are summarized in Sections 1.1 and 1.2 of this report. The interested reader is referred to the Phase I report for a detailed description of current service patterns and costs. The remaining sections of this report pertain exclusively to the development of alternative models of operation for machine services. The interested reader is referred to Volume I of the Phase II report for a discussion of alternative models of operation for braille services.

Listed below are five basic tenets regarding the development of alternative models of centralized machine operations during the course of Phase II of this study.

(1) The acquisition costs of NLS provided playback machines, machine repair parts, machine accessories and associated supplies for machine operations were outside the scope of the study, were not included in the Phase I analysis, and were not included in the Phase II analysis. However, TMC believes that centralization will generally result in *lower* acquisition costs for machines made possible by enhanced control and inventory management relative to the *status quo*.

(2) The costs of transporting NLS provided machines and associated supplies, performed by the United States Postal Service, were outside the scope of the study, were not included in the Phase I analysis, and were not included in the Phase II analysis. However, TMC believes that centralization will generally result in *higher* transportation costs for machines due to longer distance average transits between patrons and supply points, i.e., central distribution centers.

(3) The statement of work for Phase II of the study specifically required the development of *separate* alternative models for centralized braille and machine operations.

Therefore, TMC has *not* modeled *combined* centralized braille and machine operations, although this scenario is certainly feasible, and in fact may even be desirable from the standpoint of operational efficiencies in managerial/supervisory labor costs and ADP equipment costs. If the decision is made to proceed with centralization of *both* operations, this combined operational scenario should be analyzed.

(4) The method(s) by which centralized machine operations would be funded, if centralization is adopted, is outside the scope of this study, and is *not* addressed in this report.

(5) The development of alternative models of centralized machine operations in Phase II of this project was a *feasibility study, not an implementation study,* and as such, *detailed* recommendations pertaining to operating procedures, facility configuration, capital equipment and staff composition are *not* presented. However, macro-level requirements and costs for all applicable areas were developed. TMC strongly urges NLS to perform (internally, or by consultant) an implementation study of centralized operations if the decision is made to proceed with the concept.

Section 2

DISTRIBUTION ANALYSIS

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Several criteria were applicable to the determination of the best distribution network for centralized machine operations, the most important criteria being minimization of delivery time of machines to patrons, minimization of labor costs, and minimization of occupancy costs. This determination required the formulation and evaluation of a mathematical model of the network, and an examination of specific, relevant information concerning potential locations for the center(s).

2.1 PROFILE OF THE NETWORK

Appendix 3 contains a graphical profile of the network which helped in the determination of the locations for machine central distribution center(s). The appendix is a scale map of the continental United States (1/4" = 65 miles), with superimposed Cartesian (x/y) axes, and three types of symbols to indicate modeled points of demand for machines, and potential points of supply, i.e., centers for machine operations.

Points of demand for machines are approximated as being in those metropolitan areas where regional libraries are located, and in the cases of Wyoming and North Dakota (which have no regional libraries), where MLAs are located. Although this is an approximation of national demand distribution, for the purposes of this centralization study the model is more than sufficient. Note that the four regional libraries (Honolulu, Anchorage, San Juan and St. Croix) and one subregional library (Guam) that lie outside the continental United States are not included in the analysis; this omission is deliberate, and the reason is explained in the subsection on delivery times. Demand points are indicated on the map by circles (RL/MLA only) and squares (RL/MLA and postal bulk mail facilities).

The weight assigned to each demand point is the number of recorded book readers. Deposit collections were assumed to have four readers each, which is the standard NLS approximation. Appendix 4 contains a listing of the network model's demand points, showing the city, state, x coordinate, y coordinate, and recorded book readership for each demand point.

Readership, rather than circulation, was used as the weighting factor in the location analysis for two reasons. First, "circulation", *per se*, is not reported to NLS. Recorded book readership was used as a surrogate statistic for the number of machine users. Second, if centralization of machine operations is adopted, the number of machines circulated per reader will very likely become much more uniform than is presently the case due to a more uniform quality of service that will be provided to patrons relative to the present.

Potential locations for machine distribution centers, for the purposes of this feasibility study, were confined to the 29 metropolitan areas in which the United States Postal Service has bulk mail facilities, be they Bulk Mail Centers (BMCs) or Auxiliary Service Facilities (ASFs). Appendix 5 contains a listing of these bulk mail facilities showing the city, state, x coordinate, y coordinate and type of facility. The decision to constrain the potential supply points to these locations was a directive given by NLS to TMC, and a decision in which TMC concurs, the logic being to facilitate distribution center output entering the bulk mail stream on "day 1". If another choice of locations is made, one of two "penalties" would be incurred; either average machine delivery time would be increased by one-to-two days, or an incremental transportation cost would have to be incurred by the distribution centers to haul the daily output to the nearest city with a BMC/ASF. Cities which have bulk mail facilities are shown in the Appendix 3 map as triangles (BMC/ASF only) and squares (BMC/ASF and RL/MLA).

2.2 DELIVERY TIME ESTIMATION

Because minimization of delivery time of machines to patrons was one objective of the location analysis, a quantitative expression of delivery time had to be derived. Appendix 6 contains a table of published 1989 USPS Service Standards, from which an analytical function of delivery time was derived based upon the standards for Bulk Business Mail. This class of service was used as a surrogate for Free-Matter for the Blind, because a uniform standard had to exist in order for a function to be derived, and Parcel Post service does not possess such a uniform standard. For the purposes of this analysis, the delivery time function derived from the bulk business mail standard was excellent. However, because this time standard is based exclusively upon over-the-road (truck) and by-rail (train) transportation of mail, the delivery time function derived does not apply to delivery of mail to the five geographic outlier points in the network previously cited (the mail goes by ship). For this reason, the geographic outliers had to be excluded from the location analysis.

Appendix 7 depicts the derivation of a univariate, linear regression equation, that is, an equation of the form "y=a+bx", that was derived from the USPS service standard for bulk business mail. Shown in the appendix are the actual days of delivery time, actual miles from point of origin, estimated days of delivery time, the equation itself, and the "R-squared" value, which measures the degree of accuracy of the equation, which is about 92%. This equation, which was employed in the centralization location analysis, is an excellent estimator of average delivery time (in days) as a function of distance from origin (in miles), and is "weak" only in the immediate service range (metropolitan area) of the origin BMC/ASF, where it estimates about 3.3 days where actually only 2 days are required. An estimating equation of this type was essential in order to use a location optimization program that facilitated analysis for scenarios wherein two or more centers are planned.

2.3 MACHINE DEMAND CENTROID

With a model of the network developed in terms of demand and supply points, and a delivery time function formulated, the next step performed in the distribution center location analysis was the determination of the centroid, or "center of gravity", of national recorded book readership. This calculation did not depend upon the delivery time function. The centroid of recorded book readership is simply the weighted average coordinates of all demand points in the network. Appendix 8 contains a map of the continental U.S. indicating the location of the machine user centroid, marked by the symbol M. The centroid is located in south-central Illinois, with the closest major metropolitan area, and bulk mail facility, being in St. Louis, Missouri.

With the machine user centroid determined, the next calculation performed was the determination of the specific location where average delivery time to patrons would be minimized. This location could be exactly coincident with the centroid of readership, or could be different, depending upon the nature of the delivery time function, which has both a fixed and variable component, and the distribution of demand in the network.

To perform this calculation, a scale factor was computed which allowed the straight-line distances between potential supply points and demand points to be expressed in terms of over-land miles. The scale factor, computed by comparing the actual over-land distances from St. Louis, MO to 28 other metropolitan areas around the U.S. to the corresponding straight-line distances to these same points, was 1.306; that is, on average, actual over-land distances in the continental U.S. are 30% to 31% longer than straight-line distances, due primarily to transportation impediments such as

mountain ranges and bodies of water. With regards to the map shown in Appendix 3, a quarter inch represents 65 miles in terms of straight-line distance, but 85 miles in over-land distance.

The location for minimization of average delivery time was then determined by calculation of weighted average coordinates based upon the delivery time function and the distribution of demand for machines. This location is indicated on the map in Appendix 8 by the symbol M'. Note that the location of this point is not coincident with the centroid of machine users. Instead, it is approximately 160 miles further east and 45 miles further north than the centroid of users, the closest metropolitan area being Indianapolis, IN. This difference is due to the relative influence of both fixed and variable components of the delivery time function applied to the distribution of national demand. However, the difference in average delivery times between these locations is insignificant (6.2 versus 6.3 days), and the maximum delivery time is increased (10.2 versus 10.9 days) as the distance from the supply point to the west coast demand points is increased.

2.4 ONE CENTRAL DISTRIBUTION CENTER SCENARIO

Having determined the centroid of machine users and the theoretical location for a one-center operation that would minimize average delivery time to patrons, the average and maximum delivery times were calculated for ten cities that both contain USPS bulk mail facilities and are in closest proximity to the centroid and theoretical location for minimum delivery time. This information, along with the average and maximum delivery times for the readership centroid and theoretical location, is shown in Appendix 9. Also shown in Appendix 9 are the values for Seattle, WA and Jacksonville, FL, (both having bulk mail facilities) for comparison purposes only. It is evident from the data that, within this particular sector of the U.S., average delivery time is not overly sensitive to location.

If NLS were to establish a single distribution center for machines, without regard to labor and facility space costs, and in a metropolitan area wherein a BMC/ASF is located, the choice should be narrowed to St. Louis, MO; Cincinnati, OH; or Chicago, IL. Cincinnati has the shortest average delivery time (6.2 days), with the maximum delivery time being 11.2 days. St. Louis has an average delivery time of 6.3 days, with a maximum delivery time of 10.1 days. Chicago has an average delivery time of 6.2 days and a maximum delivery time of 10.4 days. It is not surprising that these three cities would be the most suitable sites for a single center, because they are in closest proximity to both the centroid of readership and minimum delivery time point.

The location analysis for one-distribution center machine operations was developed as a baseline, because a single center is the limiting case in a centralization study, i.e., a one-center operation is the most extreme form of centralization of any operation in any industry. However, a single distribution center operation for machines is absolutely not recommended by TMC, nor deemed desirable by NLS, for one very compelling reason: *if a catastrophe should occur at a single center facility, the entire national inventory of machines, not in the possession of patrons or in-transit, would be destroyed.* For this risk diversification reason, and this reason alone, *two centers* for machines are recommended. Another subsidiary, but nevertheless important reason for having two distribution centers would be to shorten the maximum delivery time to something less than 10.1-to-11.2 days (and, additionally, to shorten the average delivery time). For both of these reasons, the examination of the influence and impact of prevailing labor and facility space costs in different metropolitan areas is postponed until after a two-center location scenario is developed.

2.5 TWO CENTRAL DISTRIBUTION CENTERS SCENARIO

Location analysis for a distribution problem in which two or more centers are planned is a much more complex mathematical problem than that associated with a one center scenario. The reason for this increased complexity is that a large, often enormous, number of supply point-demand point combinations must be evaluated until the best solution to the problem is found.

Therefore, TMC employed the use of OPTISITE, a computer program developed by MicroAnalytic Corporation, which is a general purpose facility location model used extensively by private industry as a decision support tool for minimizing costs and improving service in distribution operations. OPTISITE uses sophisticated optimization algorithms to determine the best solution to distribution problems.

In this application, TMC used OPTISITE to determine the best locations, and several "next best" locations, for positioning two central distribution centers for machines, and to determine which demand points should be served by each of the two supply points. In the process of choosing locations and assigning the readership in various states to each center, the program sought to minimize average delivery time to all patrons nationally (minimizing transportation costs was outside the scope of the study). The program could not, in this application (for reasons which are not expounded upon here), incorporate the influence of prevailing facility space costs in various geographic locations into the selection process, and does not, in general, have the capability to

incorporate prevailing labor costs in various geographic locations into the analysis. For this reason, occupancy and labor costs in the "best" potential cities for distribution center locations were examined after OPTISITE made its selections of locations. This is the reason that two-center scenarios other than the optimal set of locations were also derived in the analysis. Additionally, "optimal" may mean that one combination of sites has an average national delivery time of only 0.1 days less than the next best combination of sites, a margin which is less than the standard error of estimation used in the modeling, and a margin that is realistically insignificant. Despite these limitations, OPTISITE proved to be an extremely valuable tool in the initial steps of the two-center analysis, because manual methods of analysis are grossly inadequate.

The same network problem that was modeled in the one-center scenario was modeled by OPTISITE, that is, each demand point was considered to be located in each metropolitan area wherein an RL and/or MLA is located (in the continental U.S.) with readership used as a weighting factor, and with the delivery time function as derived from USPS service standards. In its computations, OPTISITE applied optimization algorithms and proceeded through hundreds of iterations of supply point-demand point assignments in order to determine the best solution, i.e., those central sites and workload splits that minimize average national delivery time. Various combinations of "next best" sets of sites and workload splits were also calculated by the program. Additionally, a separate analysis was performed for a scenario wherein the workload for the nation was split more or less evenly between centers.

The important findings of the two-center analysis are summarized below, and presented in a table in Appendix 10.

1. The workload of the network is not apportioned evenly to the western and eastern centers due to the distribution of demand in the network, i.e., there is more total demand in the eastern than in the western part of the country. Therefore, the eastern center is sized larger (63% - to - 70%) than the western center (30% - to - 37%) for the best and next best scenarios in which average national delivery time is minimized.

2. Average national delivery times (5.3-5.5 days) are reduced by approximately one day from that of a one center operation, i.e., from over six days to over five days, for scenarios that minimize average national delivery time. Average delivery time in the western region (6+ days) is approximately one day longer than in the eastern region (5+ days) due to the longer over-land distances that must be traversed in the west relative to the east, and due to the distribution of demand within each region.

3. Maximum delivery times (7.2-8.7 days) are reduced by approximately three days from that of a one-center operation (10.1-11.2 days); this is a substantial improvement, and a relatively greater improvement than the reduction in average national delivery time. As expected, the maximum delivery times occur in the western region; eastern region maximum delivery times range from 6.5-to-7.1 days.

4. The states of Minnesota, Iowa, Missouri, Arkansas and Louisiana are in a geographic area which is marginally sensitive to the center of assignment. From the perspective of minimizing both national average delivery time and maximum delivery time (which always falls in the western region), these states should be assigned to the eastern center. From the standpoint of making the workload of the two regional centers more comparable, they should be assigned to the western center.

5. Salt Lake City, Utah and Denver, Colorado are the two most favorable sites for machine centers in the western region, and Cincinnati, Ohio and Pittsburgh, Pennsylvania are the two most favorable sites for machine centers in the eastern region. Appendix 10 presents the important statistics for these sites for each combination of locations, and additionally within each of these combinations, the statistics for the cases when either the western or the eastern center is responsible for the states of Minnesota, Iowa, Missouri, Arkansas and Louisiana. Appendix 11 contains a map of the continental U.S., indicating the locations of these four metropolitan areas and the regions of service for each center.

6. An additional scenario was examined whereby the western and eastern centers would be sized approximately equally in terms of workload. Appendix 12 contains a map of the continental U.S. indicating the states that would fall into the western and eastern regions and the centroid of demand for each region. Also indicated on the map are the two most favorable locations for such an operation considering both average and maximum delivery times; Denver, Colorado in the West, and Washington D.C. in the East. The important statistics for this particular combination of sites are shown in Appendix 13. Although Oklahoma City, Kansas City and Des Moines each have slightly lower average delivery times than Denver, the maximum delivery time of 9.2 days versus 7.9 for Denver makes Denver superior in the West. In the East, Washington D.C. has the lowest average and maximum delivery times.

All of the above findings pertain to the determination of the best eastern and western locations for two-center distribution scenarios for machine operations with respect to delivery times only, and without regard to labor and facility space costs. All of the scenarios for two-center operations depicted in Appendix 10 are very close in average delivery times and maximum delivery times, with the exception of the scenarios wherein Salt Lake City would serve the five states immediately west of the Mississippi River (maximum delivery time equals 8.7 days). Therefore, the final determination of the best metropolitan areas in which to locate the eastern and western centers relies on an examination of the prevailing costs of labor and facility space in those areas.

2.6 MORE THAN TWO CENTRAL DISTRIBUTION CENTERS

As the number of central distribution centers for machine operations is increased from two-to-three, three-to-four, and so forth, both the average delivery time and maximum delivery time within each service area, and for the network as a whole, decrease. This trend is intuitively obvious, with the limiting case being the existing network of one (or two) supply points in each state. However, the improvement in average and maximum delivery times in a three-center scenario is not as significant as one might think. The best combination of sites derived for a three-center operation is: New York, NY; St. Louis, MO; and San Francisco, CA, with an average national delivery time of 4.8 days and a maximum delivery time of 6.7 days. Furthermore, as the number of central distribution centers is increased from one-to-two, two-to-three, and so forth, the economies of centralization such as enhanced inventory control, supervisory/managerial efficiencies, space utilization, etc. are diminished.

TMC recommends that if NLS adopts the concept of centralization of machine operations, that a two-center operation be implemented. As shown previously in the delivery time analysis, a two-center operation should yield average delivery times of 5.3-5.5 days, with maximum delivery times of 7.2 - 7.6 days (applicable to a very small percentage of readership). This number of centers will maximize the potential efficiencies of centralization, while providing risk diversification by having machine inventories housed in more than one physical location.

2.7 PREVAILING LABOR COSTS

The next step performed in the distribution analysis was an examination of the prevailing costs of labor in those metropolitan areas that have postal bulk mail facilities, and more specifically, in those five metropolitan areas that are the most favorable locations for situating central distribution centers with regards to minimizing average and maximum delivery times of playback machines to patrons. These five metropolitan areas are: Denver, Colorado; Washington, D.C.; Cincinnati, Ohio; Pittsburgh, Pennsylvania; and Salt Lake City, Utah. For this examination, macro-level measurements of labor costs were desired, not labor costs associated with specific occupations. Three potential measures of labor costs were identified, with one of these three clearly being the most representative, timely and comprehensive measurement to use for the purposes of the analysis.

The U.S. Bureau of the Census compiles a statistic called "Per Capita Money Income for 50 Largest Cities." These statistics were examined, but discarded for three reasons. First, income includes more than earnings, and it is earnings which must be focussed upon for the comparison. Second, data was lacking for some of the five most favorable sites. Third, the most recent data was for 1985, which is four years older than the data used in Phase I of the study for determination of network baseline costs.

The U.S. Bureau of the Census also compiles statistics called "City Government Employment and Payroll - Selected Large Cities." One specific statistic in this set of data is average earnings, i.e., average wages, which is the measurement needed for the comparison. However, this statistic was also rejected for three reasons. First, wages applicable to city government jobs alone restrict the comparison to a degree that is more than desirable. Second, data was lacking for some of the five most favorable sites. Third, the most recent data was for 1986, which is three years older than the Phase I study timeframe of 1989.

The most representative, timely and comprehensive measurement of macro-level labor costs found is published by the U.S. Bureau of Labor Statistics, and called "Average Annual Pay, By Selected Metropolitan Areas." This statistic was compiled for 1987, indicates average earnings by metropolitan area, and was available for all five of the most suitable locations for centers and for 24 of the 29 metropolitan areas that have bulk mail facilities. This data is shown in Appendix 14, sorted in ascending order of average annual wage, along with the relative ranking (relative to the average wage for all 24 known cities) for each metropolitan area, and with the values for the five most suitable sites highlighted. The following two conclusions can be deduced from examination of the data in Appendix 14:

- With regards to the distribution center for the West, Salt Lake City, Utah is clearly more desirable than Denver, Colorado. Although Denver is only 3% above average labor cost for all 24 cities compiled, Salt Lake City is 14% below the average labor cost, and in fact, is the lowest of all 24 cities. On a direct comparison basis, average wages are 20% higher in Denver than they are in Salt Lake City.

- With regards to the distribution center for the East, Pittsburgh, Pennsylvania and Cincinnati, Ohio are very close in value, and hence of virtually equal desirability. Pittsburgh is 5% below average wage for all 24 sites compiled, and Cincinnati is 4% below the average. On a direct comparison basis, Cincinnati's average wage rate is 0.9% higher than Pittsburgh's average wage rate. Washington D.C., which is a desirable location only for the Denver-Washington equal workload scenario, is very undesirable with regards to labor costs; Washington is the third most expensive labor

site of the 24 sites examined, and is 20% and 19% higher than Pittsburgh and Cincinnati, respectively.

2.8 PREVAILING OCCUPANCY COSTS

The final step performed in the distribution analysis was an examination of the prevailing costs of facility space in those metropolitan areas with postal bulk mail facilities, and in particular, Denver, Washington, Cincinnati, Pittsburgh and Salt Lake City. The type of facility space appropriate for an operation such as centralized machine storage, distribution and repair is warehouse space. This category of space is different from that employed by many (but not all) of the library sites visited in Phase I of the study, but is nevertheless the appropriate category of space to plan for in a feasibility study such as this. The envisioned centers would be large-scale storage and distribution operations, and although there is no intrinsic reason that walk-in patrons could not be accommodated in such a scheme, "library space", as defined in the Phase I report, is unnecessarily expensive for the intended purposes of the centers.

Consistent with the approach used in Phase I of the study for the determination of the unit occupancy costs of library facility space in various geographic locations, TMC used information provided by the United States General Services Administration's (GSA) RENT system database. This database contains the fully loaded (space, utilities, maintenance and security) unit occupancy costs of all warehouse space managed by GSA in various metropolitan areas around the country. Unlike library space unit occupancy costs, which were calculated as 75% of office space rates, warehouse space costs are determined directly from appraisal by private, professional real estate appraisers, i.e., it is considered by GSA to be, like office space, a fundamental category of facility space.

Appendix 15 contains a listing of average unit occupancy costs (dollars per square foot per year) for 24 of the 29 cities in which the USPS has bulk mail facilities and in which GSA manages warehouse facilities. The listing has been sorted in descending order of unit occupancy cost, with an additional column showing the relative ranking of each city's unit cost to the average unit cost for all 24 known sites. The data for the five cities that are the most suitable sites with regards to delivery time minimization are highlighted in this listing. The following two conclusions can be deduced from examination of data in Appendix 15:

- With regards to the distribution center for the West, Salt Lake City, Utah is clearly more desirable than Denver, Colorado. Although Denver is 17% below average cost for all 24 cities compiled, Salt Lake City is 35% below average cost. On a direct comparison basis, average warehouse space costs are 27% higher in Denver than they are in Salt Lake City.

- With regards to the distribution center for the East, Cincinnati, Ohio is clearly more desirable than Pittsburgh, Pennsylvania, with a cost 25% below average cost for all 24 cities compiled. Pittsburgh's unit cost is 16% above average cost for the 24 cities, and is 55% higher than Cincinnati's unit cost on a direct comparison basis. Washington D.C., which is a desirable location only for the Denver-Washington equal workload scenario, is undesirable with regards to facility space cost; Washington's cost is 20% above average cost for the 24 sites compiled, and is 61% higher than Cincinnati's cost on a direct comparison basis.

2.9 BEST CONFIGURATION FOR CENTRAL DISTRIBUTION

The important criteria applied in the distribution analysis were the minimization of delivery time of machines to patrons of the free library service, the minimization of labor costs, and the minimization of facility space costs, in that order of importance. Additionally, potential distribution center locations were constrained to the 29 metropolitan areas wherein USPS bulk mail facilities are located. Furthermore, a one-center scenario was discarded for risk diversification reasons, and a scenario with three or more centers was discarded because the marginal improvements in average and maximum delivery times are more than offset by decreasing economies of decentralization, with the limiting case being one or two distribution centers in every state.

If NLS adopts the concept of central distribution for playback machines, TMC recommends that the western center be situated in Salt Lake City, Utah and that the eastern center be situated in Cincinnati, Ohio. This combination of sites is the best configuration for central distribution, all relevant constraints and objectives considered. This recommendation, and the analysis supporting the conclusion, was in no way influenced by the fact that NLS currently operates two of its three MSCs in these locations. Rather, TMC believes that NLS made a prudent choice when it decided years ago to situate MSCs in these locations.

TMC believes that there is absolutely no compelling or intrinsic reason why the centers for the western and eastern regions should be sized equally in terms of readership served. As shown in the analysis, the best combination of sites for an equal workload scenario would have Denver, CO serving as the western site and Washington, D.C. as the eastern site. This operational scenario would

be considerably more expensive than the recommended combination of sites, and would also increase both average and maximum delivery times relative to the recommended combination.

One additional factor that was not a major consideration in the distribution analysis was prevailing weather conditions at potential sites, both because only the primary (delivery time) and secondary (cost) factors were scrutinized in the distribution analysis, and because over-land transportation of the mail (especially by rail) is generally not as sensitive to harsh weather conditions as is the case for mail transported by air. Prevailing weather conditions at potential distribution sites should, however, be considered a tertiary factor in the location of centers. With regards to prevailing weather conditions, Salt Lake City is generally more favorable than Denver, and Cincinnati is generally more favorable than Pittsburgh.

There is one somewhat discretionary decision that NLS must make if the two-center, Salt Lake City-Cincinnati recommendation is adopted: should Salt Lake City, or Cincinnati, service the states of Minnesota, Iowa, Missouri, Arkansas, and Louisiana? The trade-off in this decision being a greater share of total national workload for Salt Lake City (37% versus 30%) versus an increased maximum delivery time (8.7 versus 7.6 days) and average delivery time (6.3 versus 5.9 days) for western region patrons (eastern region maximum and average delivery times are virtually unchanged by this variation in workload split).

Section 3

CENTRALIZED MACHINE OPERATIONS

Section 3
CENTRALIZED MACHINE OPERATIONS

In this section of the report, macro-level operating procedures, workload requirements, resource requirements and estimated costs for centralized machine operations are presented. The discussion is presented in six parts in the following order: workload requirements; operating procedures; labor requirements and estimated costs; occupancy requirements and estimated costs; all other requirements and estimated costs, and; conclusions.

3.1 WORKLOAD REQUIREMENTS

The mission of the envisioned machine central distribution centers is to store and repair the national collection of recorded book playback machines and to distribute these machines to patrons of the national free library program. Based upon the distribution analysis detailed in Section 2 of this report, the best central distribution configuration for machine operations would be two centers, one located in Salt Lake City, Utah, and the other located in Cincinnati, Ohio. This conclusion was based upon the constraint of locating the centers in metropolitan areas with postal bulk mail facilities, with the primary objective of minimizing delivery time of machines to patrons, the secondary objective of minimizing operating costs, and a tertiary consideration of prevailing weather conditions to the extent that delivery times and/or distribution operations would be impacted. Workload can be categorized into four major components which are discussed in the following order; readership to be served, repairs to be performed, circulation to be generated, and inventories to be housed.

Readership to Be Served

National recorded book readership in federal FY 1989 as reported by network libraries was 672,540 patrons. This total was derived by adding to the total number of reported individual patrons an additional component of four times the number of reported recorded book deposit collections, which is the standard NLS approximation. As detailed in Section 2 of this report, it was shown that under the optimal operating scenario the eastern center would be considerably larger than the western center, in terms of number of patrons served, due to the geographic distribution of recorded book readership. It was furthermore shown that the five states immediately west of the Mississippi River could be served by either center with marginal impact on national average delivery time, the relevant

tradeoff being a reduction in maximum delivery time in the western region versus load leveling of operations at both centers.

Ultimately, if the concept of centralization is adopted and implemented, NLS and the network must decide upon this variation in workload split. For the purposes of this feasibility study, TMC has assumed that the western center would service these five states, resulting in a 37% - West/63% East workload split rather than a 30% - West/70%-East workload split. These workload split percentages remain constant whether or not Alaska and Hawaii are served by the western center, or Puerto Rico and the Virgin Islands are served by the Eastern Center. It may not be feasible to serve these patrons from the centers due to excessive required delivery time, unless the deliveries are expedited and/or adequate "reserve" inventories are managed by these outlier sites. Under this assumption, the western center would serve 245,470 patrons in the continental U.S. (2,260 in Alaska and Hawaii), and the eastern center would serve 422,690 patrons in the continental U.S. (2,120 in the Virgin Islands and Puerto Rico), based upon FY 1989 workload (reference Appendices 4 and 10).

Appendix 16 shows a more detailed profile of network recorded book readership than is shown in Appendix 4, specifically individual, deposit collection and total readership for both disc and cassette books taken separately and in combination, for each region and in total for the network. The percentages of total national readership for each of the two media types falling into each of the two regions are very close to the percentage of the network total for each region. The western center would service a region with 37% of total recorded book readership, 34% of disc readership and 38.5% of cassette readership, while the eastern center would serve a region with 63% of total recorded book readership, 66% of disc readership and 61.5% of cassette readership. Therefore, demand for each of the two basic types of machines within each region is in close proportion to total demand.

Repairs to Be Performed

The total number of non-warranty playback machine repairs performed in federal FY 1989 as reported by network libraries and MLAs was 150,178, of which 32,881, or 22%, were repairs to Talking Book Machines (TBM) and 117,297, or 78%, were repairs to Cassette Book Machines (CBM). These statistics, shown in Appendix 17, were also reported by whether the repairs were performed by the Telephone Pioneers (TP) organization, or by "other" than the Telephone Pioneers.

The non-TP category is a mixture of repairs performed by paid in-house staff, contractors and other non-TP volunteers; what proportion of these repairs are performed by volunteers and by non-volunteers is unknown. Of the 150,178 total repairs, 98,179 repairs, or 65%, were performed by TPs, and 51,999 repairs, or 35%, were performed by non-TPs. These proportions also hold for repairs by machine type (TBM - 64.4% TP, CBM - 65.6% TP).

Repair statistics subtotals for each region are also shown in Appendix 17, with 67% of repairs having occurred in what is defined as the eastern region for this study, and 33% in the western region. It is assumed that if centralized repair operations were implemented at two centers, then the repairs would occur in proportion to readership (37% - West, 63% - East).

As part of the baseline alternative operating scenario in this feasibility study, TMC was directed to examine the repair function as being either entirely performed by in-house paid staff, or by contractor. Based upon input from several large machine operations, of the machines repaired by volunteers (TP or non-TP), 13-14% are returned for additional repairs that would not have been returned for such subsequent repair had paid staff and/or a contractor performed the repairs. This difference between volunteer and non-volunteer return rates is primarily due to the fact that a contractor is held to quality control standards, unlike volunteers, and paid staff tend generally to perform more comprehensive repairs than is true for volunteers. Unfortunately, the workload split between non-TP volunteers and paid staff/contractor repairs is unknown, except that 7,914 of the 51,999 subtotal were done under contract for NLS. Therefore, a conservative approach was used, and only the number of TP repairs was adjusted downwards by 13.5% for estimation of pro-forma machine repair workload.

With the above assumptions made, the calculation of the estimated repair workload for each center, and in total for the network, was straightforward. In a baseline scenario, the network would require 30,022 TBM repairs per year, of which 11,108 (37%) would be performed at the western center and 18,914 (63%) would be performed at the eastern center, and 106,902 CBM repairs per year, of which 39,554 (37%) would be performed at the western center, and 67,348 (63%) would be performed at the eastern center, for a grand total of 136,924 repairs per year.

Circulation to Be Generated

"Machine circulation", that is, the number of issues and receipts of playback machines, is not a statistic that is typically tracked and compiled by network libraries and MLAs, although some facilities do record this data. It is also a statistic that NLS does not request from network libraries and MLAs, as it does for machine repairs, machine inventories and recorded book readership.

Issues of machines are currently required for disbursement to new, first-time recorded book patrons, for disbursement to existing patrons who have defective machines, for mailing to warranty repair locations, and for disposal. Receipts of machines occur when defective machines are returned by patrons, when working and/or defective machines are returned by patrons who leave the service for any reason (including returns by others on behalf of deceased patrons), when new machines are received from point of manufacture or supply, and when machines having undergone warranty repairs are returned.

Appendix 18 shows a calculation of pro forma machine circulation at the envisioned machine centers, for the network and each center individually, by the number of machines received and issued. The number of issues for both centers totals 212,624 machines (both CBM and TBM), which is composed of approximately 69,500 issues to new patrons (per CMLS), 136,924 issues of replacement machines to existing patrons (per pro forma repair workload), 3,000 issues for warranty repairs, and 3,200 machines disposed of. The number of receipts for both centers totals 240,166 machines (both CBM and TBM), which is composed of 52,242 machines from patrons leaving the service, 136,924 defective machines being returned for repair from existing patrons, 3,000 machines being returned from warranty repair, and 48,000 new machines received from manufacturers. Thus, the western center would be issuing 78,671 and receiving 88,862 machines per year, and the eastern center would be issuing 133,953 and receiving 151,304 machines per year, based upon FY 1989 network operations.

Inventory to Be Stored

The total inventory of playback machines assigned to patrons, available for assignment and in repair at network libraries and MLAs at the end of federal fiscal year 1989 was 751,909 machines, of which 246,854 (33% of total) were TBMs, and 505,055 (67% of total) were CBMs. Of these subtotals, 88.5% of all TBMs were assigned, 6.5% were available for assignment, and 5.0% were

awaiting repair, while 82.8% of all CBMs were assigned, 8.7% were available for assignment and 8.6% were awaiting repair. In addition to these machines, there were also several thousand more new machines in bulk storage at the MSCs.

Given the 37% - West/63% - East workload split, the western center would be responsible for 91,336 TBMs and 186,870 CBMs, and the eastern center would be responsible for 155,518 TBMs and 318,185 CBMs. In addition to responsibility for these inventories and the several thousand machines stored in bulk at the MSCs, some minor allowances would also have to be made for storage of various machine accessories.

Appendix 19 indicates that 11.5% of TBMs were either awaiting repair or available for assignment at the end of FY89, while the corresponding value for CBMs was 17.2%. This means that 15.3% of total machine inventory was on location in network MLAs and libraries, either in storage locations or repair areas, with the exception of machines in repair off premises. Therefore, it appears on face value that provision should be made at machine centers to allow for the storage of 15% of the aggregate national collection of machines. However, the weighted average value for this same statistic for the sixteen RL sites in the sample that conduct machine operations was about 10.5% of total inventory. Therefore, if 15% of total machine inventory is used as a planning parameter, a conservative allowance would automatically be made for the storage of various accessories and supplies necessary for operations.

3.2 OPERATING PROCEDURES

In this subsection, operating procedures for the envisioned machine distribution centers are briefly addressed. As stated earlier in the report, if the concept of centralized machine storage, repair and distribution is adopted by NLS, the performance of an implementation study is essential; in no facet of planning centralized operations is this more true than for the development of best operating procedures. It could be argued, therefore, that operating procedures should not be addressed at all in this feasibility study report. However, TMC believes that the basic framework of central distribution center operating procedures should be established in the feasibility stage of evaluation.

Based upon input and guidance provided by both network representatives on the study Advisory Committee and upon input and guidance provided by NLS staff, TMC has developed a baseline operating scenario for centralized machine operations. This baseline operating scheme

essentially involves the machine centers acting as service points for network libraries and agencies, with the only direct interaction between the centers and patrons being the issues and returns of machines themselves, except for machine center participation in contacting patrons concerning the return of overdue machines. Other variations upon this baseline operating scenario are possible, but the examination of such secondary alternatives must be reserved for an implementation study, and are *not* addressed in this report.

In Phase I of this study, ten fundamental functions were identified which are currently performed in network libraries and/or MSCs that constitute the whole of book and/or machine operations. All of those functions relevant to machine operations would still be required under a central distribution operating scheme. These ten functions are discussed below.

Set-up; maintain patron files - *This activity includes the initial registration of patrons with the service, including enrollment in the CMLS direct circulation magazine program, and patron record updates or changes of any kind.*

This function would be performed at network libraries rather than at the machine centers, because: (1) network libraries have expressed a desire to retain close ties to patrons; (2) this function would occur anyway at network libraries for recorded book operations, and duplicating this effort at machine centers would be redundant, and; (3) the registration of patrons with CMLS is an activity that is peripheral to the intended mission of the machine centers.

TMC envisions libraries performing this task much as they do now, which includes: verification of patron eligibility; entering into a computer database essential patron data such as name, key numeric identifier, address, whether or not the patron desires talking books and/or cassette books, and secondary information such as sex, age, handicap and foreign language abilities; maintenance of the patron file such as changes of address, or if the patron leaves the service for any reason; and CMLS registration. Relevant data on new recorded book patrons enrolled, specifically name, key numeric identifier, address and media requirements would be telecommunicated or otherwise conveyed electronically in a standard format for compilation on the computer system at the centers. For those patrons already in possession of machines at the time of conversion to centralization, the previously cited information would also be conveyed to the machine centers, along with information (model and serial number) concerning the machines that the patron currently has in possession (a "now has" file) and information concerning the patron's previous machine history. Any changes to patron records

that would impact machine center operations, such as address changes, withdrawal from the service, etc., would be forwarded to the machine centers.

In this operating scheme, libraries would have to have access to a shared patron database that would be resident at the machine centers. This database would be updated by network library personnel, as far as new patron registration or specific changes to patrons' records are concerned, and updated by machine center personnel, as far as tracking specific machines issued to or received from specific patrons is concerned. A two-way communications capability would, therefore, be required that would facilitate the query or modification of patron data resident at the centers by appropriate library personnel.

Check-in; shelve - *This activity includes the receipt, sorting, checking-in and putting away of new or returned machines.*

Only machines would be carried at the centers, as opposed to machines, recorded books and braille now carried at libraries. Therefore, one primary sort that is currently necessary in libraries, that of separating braille, recorded books and machines, would be eliminated. Returned machines would be discharged in the receiving area via wanding of bar-codes or OCR codes, simultaneously relieving the patron records of returned machines, and adding the returned machines to the machines available or machines to be repaired inventories.

Because patrons would be directed by their network library advisors to return both defective and permanently returned machines directly to the machine centers rather than network libraries, check-in and shelving should not be required at network libraries. However, any machines that are returned on a walk-in basis to network libraries by patrons would be physically forwarded to the centers from the libraries. As to whether a library or the center would credit a walk-in patron's record with the return of a machine is a detail that should be determined in an implementation study.

Inspection - *This activity includes the effort associated with machine inspection performed upon the issuance and/or the return of machines.*

Any machine "inspection" performed would be the responsibility of the machine centers. Inspection, as a distinct function, is really not applicable to machines, i.e., if machines are new, they are presumed to work properly, and if they have left repair operations and are in the "available"

inventory, they are also presumed to work properly. Therefore, any inspection of machines that occurs would take place during repair diagnostics, which would be the sole responsibility of the machine centers.

Duplication of Books - *This activity includes the reproduction of NLS books.*

This function is not applicable to machine operations, i.e., machines are not "duplicated".

Build and Maintain Collection - *This activity includes all machine inventory management functions.*

Because the machine centers would be the entity ultimately responsible for maintenance of the free library program's machine inventory, the centers would be responsible for this function. To the extent that network libraries would house extremely small depository collections of machines for issue to new (or possibly existing) walk-in patrons, a collection would be housed, but the inventory management responsibilities will reside at the machine centers. This function, defined as overall inventory management, was captured and costed separately from input and output functions that eventually impact inventory-on-hand; input and output activities are described in other parts of this subsection.

Approximately 85% - 90% of the national machine inventory would be on loan or in-transit at any given time, and 10-15% would be on-hand either awaiting repair, or available for issue. The key to effectively maintaining control of the inventory of machines is for the centers to know, at any moment in time, exactly which and how many machines are in repair, available for issue, or on loan, and if on loan, who is in possession of them.

Obviously, including more supply points than the centers themselves complicates this function. However, network representatives on the study Advisory Committee have so unambiguously expressed a requirement that a centralized operating scheme allow some modest depository collections to be positioned at some network library sites, that these sites would effectively be secondary supply points. As mentioned above, however, inventory management, *per se*, would only be conducted at the centers, while these secondary supply points would be responsible for updating the centers' databases for any issues from these depository collections.

Repair Machines - *This activity includes any diagnostics, clean-up, record keeping and electro-mechanical repairs performed on machines.*

The above function is self-explanatory, and would be the exclusive responsibility of the machine centers. The repair functions envisioned under centralized operations would consist either of a team of in-house electrical technicians performing the repairs on-site, or a team of contractor personnel performing the repairs on-site or off-site. Because the evaluation and costing of the machine repair parts operation was outside the scope of this study, it is assumed that NLS would retain the procurement and storage functions for machine repair parts and issue them to the centers and/or repair contractor as required. A secondary scenario that could be evaluated in an implementation study would be to have a small number of highly monitored, centralized volunteer repair groups augmenting the resources of the in-house or contractor repair operations.

Receive requests, make selections - *This activity includes the receipt of all patron requests for machines, the generation of orders to fulfill these requests, and any advisory services for patrons.*

This function would be the complete responsibility of network libraries in centralized machine operations, with the machine centers having no direct contact with patrons. All walk-in and telephone (and, possibly mail-in) requests for new or replacement machines would be processed by network libraries, as would all requests pertaining to problems associated with machine operations. With the exception of libraries placing orders against their own depository collections, if indeed this split inventory *modus operandi* is implemented, libraries would forward all orders for machine issues to the machine centers via telecommunication or alternative electronic conveyance in a standard data format for compilation and processing on the centers' ADP systems.

Check-out; delivery - *This activity includes the retrieval of machines from storage locations and their subsequent issuance.*

This function would be performed primarily at the machine centers, with the exception of issues from library depository collections, if that option is implemented. Warehouse personnel would pick orders from stock locations using ladders to retrieve machines stored over 7' high, if high vertical height warehouses are used. Workload would be evenly apportioned among warehouse personnel in the form of batches of pick-tickets/address cards. Division of labor could either be structured so dedicated personnel perform retrieval from storage and other personnel package and mail machines, or so that warehouse personnel package and mail the same machines they retrieve. The

issuance step should involve, prior to packaging, "charging" the machines out, i.e., wanding a bar-code or OCR-code on both the machines and the corresponding order cards to ensure that the machines are charged to the patrons who requested them, and a visual inspection of the machines. Pre-sorting of the daily output could expedite delivery times by about one day. The details of this function need to be addressed in an implementation study, especially with regards to the optimal division of labor to specific tasks, as do the details of whether the centers would automatically notify network libraries that specific machines were issued to specific patrons, or whether libraries should have the ability to query their patrons' records in a shared database.

Retrieve overdue machines - *This activity includes the writing and mailing of letters, phone calls and home visits to retrieve overdue machines from patrons.*

It is TMC's recommendation that the machine centers assume the primary responsibility for contacting patrons for overdue machines by computer generated form/letter and by telephone, but not by home visits. However, in circumstances involving repeated unsuccessful attempts by letter and by telephone to obtain long overdue machines from patrons, the machine centers should request that the patron's home library make attempts to obtain the overdue equipment.

Manage and support operations - *This activity includes any effort that is managerial or supervisory in nature, clerical and secretarial support, conferences and travel, and the time of any in-house programmer-analysts.*

This function is self-explanatory, and absolutely necessary at both machine centers. Each of the two machine centers would require one manager, or director, who would have overall responsibility and authority for each center's operation. Each center would require some clerical and secretarial support, for reporting requirements, correspondence and miscellaneous duties. The need for either designated supervisors or work-leaders below the level of manager is envisioned; this is true for the staff of electrical technicians (if repairs are to be performed by in-house staff) and for the staff of warehouse workers. These supervisors would spend most of their time scheduling and monitoring the work of others, and the remainder of their time (if any) engaged in direct work themselves.

Regarding the requirements for computer systems analysts/computer programmers/computer operators at the centers, TMC envisions, for a baseline scenario anyway, that each center would rely primarily on contracted support for systems analysis and maintenance, programming, and trouble-

shooting, while having on staff at least one individual capable of operating the system. This requirement assumes that a "free-standing" ADP system would be resident at each of the two centers. However, an alternative which should be evaluated in an implementation study is a free-standing system at only one of the centers, acting as a host system for the other center.

3.3 ESTIMATED LABOR REQUIREMENTS AND COSTS

Two scenarios were examined regarding the total labor costs for the envisioned machine distribution and repair centers. One scheme involved all machine repairs being performed by in-house staff, and another scheme involved all repairs being contracted out.

In Appendix 1 of this report, total current labor costs for machine operations at network libraries as estimated in Phase I of the study is shown to be approximately $5,015,000. With a current national recorded book readership of 672,540 patrons, this equates to $7.46 per patron served per year. Alternatively, with a current national machine inventory of 751,909 machines, this equates to $6.67 per machine managed per year. Additionally, approximately $45,000 was expended for labor for machine operations at MSCs, bringing the total per reader and per machine costs to $7.52 and $6.73 per year, respectively, and the grand total network labor cost for machine operations to $5,060,000 per year.

Appendix 20 presents the total labor cost per machine for machine operations during 1989 for each of the 16 regional libraries visited during the course of Phase I of this study that are machine lending agencies. Two sets of data, each containing three statistics are shown in this table; each set of data shows the labor cost per machine and the total machine inventory side by side, with the first set sorted in descending order of cost per machine, and the second set sorted in ascending order of machine inventory managed. Also shown in this table are the unweighted average, weighted average and median labor cost per machine for the 16 sites, for those sites that do not use SRLs, and for non-SRL networks which manage more than 10,000 machines.

As noted in Section 6 of the Phase I, Volume II report (p. 13-14), there were various reasons why the costs of operations, and in this specific case labor costs for machine operations, differed among the sample sites. It was a relatively difficult job deriving the cost prediction model for labor costs in machine operations during Phase I; a step-function of stratified means was used as a predictor instead of using a regression equation. Cost estimation of machine operations was especially

complicated by the varying degree to which RLs use SRLs in their operations (if at all), and to the degree that volunteer labor was used to perform machine repairs (if at all). For the estimation of machine operation labor costs after centralization, the situation is further complicated by certain functions having to be performed at the centers, while other functions would have to be performed at network libraries (ref. Subsection 3.2).

Appendix 21 contains a breakdown of current machine operation labor costs at sample sites that was used as the basis for estimation of labor costs under centralization. Of the various combinations of unit cost and percentage of total unit cost data shown, the set pertaining to unweighted data for all 16 libraries in the sample ($6.52 per machine per year) was used for the estimate of costs to be incurred at library sites, while the set pertaining to unweighted data for large sites that don't use SRLs ($4.91 per machine per year) was used for the estimation of costs to be incurred at the machine centers. That is, the broader sample's distribution is more applicable to overall network library machine operations, while the functions performed at the centers would be more similar to the applicable functions currently performed at large RL machine operations that are not supported by SRLs (and wherein, evidently, some significant economies of scale are achieved; ref. Appendix 20).

Appendix 22 shows the calculation of pro-forma network labor costs for machine operations in both network libraries and machine centers, for both in-house and contracted repair scenarios. In the case of in-house repair, an average wage rate of $13.50/hour for electrical technicians was used (per Bureau of Labor Statistics data) in tandem with an assumed 30% fringe benefit loading rate, and an assumed average repair time of 1.0 hours for TBMs and 1.5 hours for CBMs, resulting in a total labor cost of $17.55 per TBM repair and a total labor cost of $26.33 per CBM repair. In contrast to this, the 1989 rate charged NLS for contracted machine repair was used for the contracted repair scenario, which was $27.98 per repair, regardless of the type of machine repaired or the degree of difficulty of the repair. For this contracted price, the machines are brought up to NLS quality specifications for new equipment. However, it is assumed that in-house repair performance standards would also meet NLS quality specifications for new equipment.

It should be noted here that NLS staff have determined that contractors have a greater propensity to consume repair parts than do volunteers or paid in-house staff for given types of repairs. Although repair parts operations were outside the scope of this study, TMC believes that NLS should take this into account if centralized machine repair is implemented.

As Appendix 22 indicates, the total estimated labor cost for machine operations is approximately $6,732,000, if in-house staff are used to perform machine repairs, consisting of $1,536,000 at network libraries, and $5,196,000 at the machine centers. Alternatively, the total estimated labor cost for machine operations is approximately $7,222,000, if contractors repair machines, consisting of $1,536,000 at network libraries (unchanged from the in-house repair scenario), and $5,686,000 at the machine centers. In comparison with current estimated network labor costs of $5,060,000 for machine operations, *these alternatives amount to a net increase in labor costs of $1,672,000 per year, or 33%, for the in-house repair scenario, and a net increase in labor costs of $2,162,000 per year, or 43%, for the contracted repair scenario.* Also shown in Appendix 22 are the total costs for libraries and centers, individually and in total, assuming that 10% (arbitrarily chosen parameter) of check-ins, check-outs and retrieval of overdues are performed by libraries rather than the centers; the impact on total costs is insignificant (0.2%) under this assumption.

3.4 ESTIMATED OCCUPANCY REQUIREMENTS AND COSTS

By far the most significant economies to be gained from machine storage, distribution and repair centralization (with the exception of savings in equipment costs resulting from enhanced inventory control, which were outside the scope of this study) are savings in occupancy requirements and costs, i.e., savings in required facility space and its associated costs. These savings would result for three reasons, which are discussed below.

Economies of Consolidation. Economies of consolidation for machine operations were determined in Phase I of the study, and are exemplified by the required facility space predictor model shown in Appendix 6 of the Phase I, Volume I report, and which is also shown in Appendix 23 of this report. This model predicts total required facility area (in sf) as a function of total machine inventory managed, specifically: Total Area (sf) = 408 + 0.091 x Total Machine Inventory. What is implicit in this mathematical relationship is that the fixed component of facility area, derived in the regression analysis in Phase I of the study, is relatively large for most operations, e.g., a library which manages a total machine inventory of 10,000 machines needs 1,318 sf for its operation, of which 408 sf (31%) is the fixed component. However, a library that manages 50,000 machines requires 4,958 sf, of which 408 sf (8%) is the fixed component. A different machine operation facility space predictor model was derived for SRLs in Phase I of the study using the collection size of recorded books as the independent variable (because there are no reported machine inventory data for SRLs).

Assuming that the same general facility space configurations and storage procedures for machine operations that are currently used would be used in centralized machine operations, and that 278,206 machines would be managed by the western center and 473,703 machines would be managed by the eastern center (ref. Subsection 3.1), then 25,725 sf would be required at the western center, 43,515 sf would be required at the eastern center, and 69,240 sf would be required in total (ref. Appendix 23). This compares to approximately 121,300 sf currently used for machine operations network-wide. Thus, a net reduction of 52,060 sf, or 43% of current required facility space, could be achieved by consolidation *if all functions were to be centralized and if current storage procedures were to be employed.* However, as previously discussed, *several functions would remain resident at libraries*, and additionally, higher density storage could be achieved in centers, so the above values must be adjusted for a final determination of space requirements at centers and libraries.

Lower Unit Occupancy Costs. The envisioned machine central distribution centers would utilize warehouse space for their operations, not library space. The relatively lower unit occupancy costs (dollars per square foot per year) for warehouse space would result in substantial savings relative to the *status quo.* Appendix 15 indicates that current unit occupancy costs for warehouse space in Salt Lake City and Cincinnati are $3.46 and $3.97 per square foot per year, respectively. These costs are considerably below the typical costs for library space (ref., Phase I, Volume I report, Appendix 5), which average $11-$12 per square foot per year ($1,350,764 divided by 121,300 sf equals $11.14 per sf per year, on average). Therefore, the difference in unit occupancy costs between library and warehouse facility space would alone result in a *net reduction of 64% to 69%* in total occupancy costs for machine operations *if all functions were centralized.*

More Efficient Storage Methods. The recommended storage methods for machines in centralized machine operations does not deviate significantly from that employed in several of the more efficient libraries visited in Phase I of the study. However, since many libraries in the network do not employ these methods, a net reduction of required machine storage area could be achieved relative to the *status quo.* This determination is explained in the following paragraphs, and is detailed in Appendix 24.

Facility Space Required for Machine Storage

The calculation of required facility space for machine storage is detailed in Appendix 24 of the report. Two methods of estimation were used; a macro-level estimation based upon the facility

space requirements model derived in Phase I, and a pro-forma estimation based upon workload and preferred storage methods. Both methods of estimation yielded the same result; approximately 31,200 sf of facility space would be required at both centers for the storage of machines, accessories and associated supplies.

The macro-level estimation for total required facility space for machine operations is 69,240 sf, as previously explained (ref. Appendix 23). Based upon facility configurations at sample sites, on average 45% of the total facility area applicable to machine operations was used for the storage of machines. Therefore, 31,158 sf (45% of 69,240 sf) of facility space would be required for machine storage in centralized operations (the functions that would remain resident at network libraries, as explained in Subsection 3.2, would not impact this requirement).

The pro-forma estimation of required machine storage space is based upon the pro-forma workload of the centers and preferred methods of storage for each of the two basic types of machines. The steps involved in this calculation are detailed in Appendix 24, and are not repeated here, the major points being that preferred storage methods should take into account the dimensions of TBMs and CBMs, utilize shelf racks for storage to a height of 8', and configure the storage modules to maximize the density of machine storage. This estimation, performed independently of the macro-estimation of space requirements, yielded a total requirement of 31,210 sf, which is virtually identical to the macro-level estimation.

Facility Space Required for Other Than Machine Storage

The major non-storage areas envisioned for machine centers are receiving and shipping areas, office areas, repair areas, bathrooms, breakrooms, computer room and office supplies storage. The specific facility layout and sizing of each of these particular areas should be reserved for an implementation study. A macro-level estimation of non-storage areas for machine centers, based upon the Phase I model and current practices, yields a total non-storage area requirement for the centers of 38,082 sf (55% of 69,240 sf) *if all functions were performed at the centers.* However, some of this space would not be required at the centers because both advisory services and order generation, and initial registration and patron file maintenance, would be performed in network libraries.

Total Estimated Occupancy Requirements and Costs

Appendix 25 contains the estimated facility space requirements and costs for both centers and network libraries, individually and in total, under centralized machine operations. These total costs of $643,912 should be compared to the current estimated occupancy costs for the network of $1,389,418 per year; *occupancy costs under a centralization scheme would be approximately 46% of total existing occupancy costs for the network.* The reasons for these substantial savings are economies of scale associated with central operations, lower unit occupancy costs associated with warehouse space at the centers, and overall improved storage methods for on-hand machine inventories at the centers.

3.5 ESTIMATED OTHER REQUIREMENTS AND COSTS

Other requirements for machine operations consist of capital equipment, maintenance of equipment, various services, supplies, travel and miscellaneous needs, and administrative overhead. The total network costs for these resources were estimated in Phase I of the study to be approximately $1,367,000 per year, which is 17% of total machine operations current costs.

The extrapolation of costs for centralized operations for any particular individual resource category from sample site data was complicated by the various factors detailed in the Phase I, Volume II report, pages 13-14. This was especially true of equipment depreciation, office services and equipment maintenance, because some sites owned and operated their own ADP systems, while other sites were supported by parent or external organizations. Additionally, some sites used in-house or contractor paid staff for machine repairs, while most sites relied on machine repairs performed by volunteers. Finally, the estimation was further complicated by the fact that several functions would be performed by network libraries in centralized operations, while most functions would be performed by the machine centers.

Therefore, a baseline development of other resources and costs was made. It must be stated unambiguously here that the following estimates are *macro-level approximations*, not detailed resource requirements and costs. It is simply inappropriate in this feasibility study to attempt a detailed calculation of costs for each category, specify manufacturers and models of capital equipment, and determine other details that are the very substance of an implementation study. Furthermore, because the potential sampling error in the Phase I analysis was $\pm$ 10%, which amounts to $136,000 for

machine operations other costs (all MSCs were visited, otherwise it would be $137,000), an estimate of the total of these other costs that is too high or too low by several tens of thousands of dollars, or for that matter as much as $100,000, is statistically insignificant.

With the above caveats and qualifications stated, listed below are macro-level requirements and cost estimates for centralized machine operations other costs. In most instances, cost approximations were made based upon actual expenditures by libraries conducting large machine operations and extrapolated on the basis of readership served.

- Automatic Data Processing (ADP) Equipment. It is assumed that each center would have a free-standing ADP system, and the acquisition cost of the system (including all peripherals, terminals, telecommunications hardware etc..) for each center would be $300,000. Assuming that the systems have ten-year estimated useful lives, which was the assumption used for major computer systems in the Phase I analysis, the average annual cost associated with the purchase of the ADP systems is **$60,000.**

- ADP Systems Maintenance and Support. As was described in Subsection 3.2 of the report, it is assumed that all systems support, maintenance, programming and troubleshooting would be provided by contractor support. The approximate cost of these services is assumed to be $30,000 at each center, or **$60,000** per year in total.

- Storage Racks. The combined storage requirement at both centers will require about 42,000 linear feet of shelving. Using the same depreciation cost for shelving (MSC type industrial shelving) that was used in Phase I of the study, $0.072/LF/year, an average annual cost of **$3,000** is calculated.

- All Other Capital Equipment. It is assumed that the average annual depreciation of all assets other than ADP equipment and shelving would be approximately **$30,000** per year. This estimate, although it encompasses depreciation of all office furniture and equipment, and all equipment required for machine repairs, is probably conservative, not liberal.

- Supplies. The total estimated cost for operating supplies for both centers would be approximately **$90,000** per year, which includes all office and warehouse supplies that were costed in the Phase I analysis. This cost excludes mailing boxes and packaging materials for machines, repair parts for machines, and any other supplies which are NLS furnished, which were outside the scope of the study, and were not costed in the Phase I analysis.

- Equipment Maintenance and Rental for Non-ADP Hardware. The estimated cost for all non-ADP equipment maintenance and/or rental at both centers is **$15,000** per year.

- Phone Lines. Telephone line costs would be approximately **$20,000** per year. This cost refers exclusively to voice communications costs borne by the centers. Patrons would *not* be contacting the centers directly in envisioned operations.

- Telecommunications. There is a requirement that network libraries convey electronically to the machine centers data on new patrons added to the service, patrons to be deleted, and all orders placed by patrons for replacement machines. The telecommunications requirement between centers would be minimal. This cost, which excludes hardware (which was included in the ADP estimate), is assumed to be **$200,000** per year.

- Travel. Travel costs are approximated at **$16,000** per year in total.

- Miscellaneous. Miscellaneous costs are approximated at $15,000 per year per center, or **$30,000** per year in total.

- Administrative Overhead. The same general rule was applied for the estimate of administrative overhead for centralized operations as was true for the Phase I analysis when actual administrative overhead was unknown, i.e., 10% of loaded labor. Therefore, approximately **$519,000** per year would be incurred for administrative overhead support for the in-house repair scenario. For the contracted repair scenario, however, it is estimated that approximately **$229,000** would be required for administrative overhead (10% of loaded labor less contracted labor, and 1 FTE @ $40,000 per year at each center for contract administration for repair operations). These estimates may be conservative, considering that MSC parent organizations only charge NLS about 4% to 5% of loaded labor costs, but for the sake of consistency, it is the estimate used here.

- Other Costs for Network Libraries. The estimated other costs that would be incurred by network libraries to support the functions remaining resident after centralization is approximately **$425,000** per year (31.3% of $1,358,000).

Given the above macro-level estimates by cost category, total non-labor, non-occupancy costs for centralized machine operations would be approximately $1,469,000 per year for the in-house scenario, and $1,178,000 per year for the contracted repair scenario. *This is a net increase of $102,000, or 7%, or a net decrease of $189,000, or 14%, relative to present network operations, respectively.*

3.6 CONCLUSIONS REGARDING CENTRALIZED MACHINE OPERATIONS

Conclusions regarding the economy, feasibility and desirability of centralized machine operations are not "clear-cut." There are several reasons for this situation.

Based upon the cost analyses performed in this study, it appears on face value that machine centralization is not economical. Two scenarios were modeled for centralized machine operations, one scenario wherein in-house staff would perform machine repairs at the centers, and one scenario

wherein repairs would be performed under contract. The total estimated annual costs for each of these two operating schemes, based upon FY1989 workload, are $8,845,000 for the in-house repair scenario, and $9,044,000 for the contractor repair scenario. In comparison with total network current costs for machine operations, which was estimated in Phase I of the study to be $7,816,000 per year, these alternative scenarios would be $1,029,000, or 13%, and $1,228,000, or 16%, more expensive than current operations, respectively.

However, TMC nevertheless recommends that NLS *not* discard the concept of machine operations centralization outright solely on the basis of this cost analysis. There are four reasons for this recommendation, which are listed below.

(1) The primary reason that costs under a centralized mode of operations are more expensive than those for current operations is because paid staff, whether in-house or contractor, would perform repairs as opposed to the current *modus operandi* whereby volunteers perform approximately 75% of required repairs (it is not known exactly what the figure is, the minimum is 65%). It was assumed that, on average, a TBM takes 1.0 hours to repair, and a CBM takes 1.5 hours to repair (parameters given to TMC by NLS). Total labor costs for repairs, which is 38% of *total* projected cost (and 50% of projected labor cost) is *extremely* sensitive to these repair time estimates. If actual average repair times are higher or lower than these estimates, total cost is significantly impacted. Based upon data obtained at two visited sites that use exclusively paid in-house staff for machine repairs, it appears that these repair time estimates may be high.

An additional reason that TMC believes the repair time estimates may be high is the rate currently charged NLS by contractor for machine repairs, which is $27.98 per machine (1989 rate, regardless of machine type). Given that 78% of repairs are to CBMs, and 22% of repairs are to TBMs, the 1.0 hour TBM/1.5 hour CBM assumption yields an average repair time of 1.39 hours per machine. Because most appliance and equipment repair firms charge a rate that is approximately twice the unloaded direct rate of their repair staff, this would mean the contractor should be charging NLS $13.5 x 2 x 1.39 = $37.53 per repair *if* it indeed takes their staff the assumed times to make repairs. This 100% loading rate on direct labor is usually reduced if repairs are made on customer premises (lower overhead), but the subject contract repairs are made on contractor premises. Therefore, based upon the above calculation, the repair time estimates may be high by 34%. If this is true, then the estimated in-house labor cost could conceivably be reduced by 34%, or $1.1 million.

(2) Although the study focused on 1989 operations and workload, TMC has learned from NLS that the future trends for network machine operations will involve the production of playback machines that are considerably more sophisticated than current machines, utilizing microprocessor controlled electronics. The repair of these newer machines will require sophisticated and expensive diagnostic equipment, and repair staff specifically trained to use the diagnostic equipment and made the repairs. TMC believes that centralized operations will become essential, at least for the repair

function, once these newer machines have largely replaced the existing inventory of machines, i.e., it would not be feasible or economical to perform these more complex repairs on a decentralized basis.

(3) One aspect of current network machine operations that was outside the scope of the study was the current and projected consumption of machine repair parts. TMC was informed by NLS staff that contractors have a greater propensity to consume repair parts, for given types of repairs, than do volunteers or in-house paid staff. If this is indeed the situation, and if centralization of repairs is implemented, then the case for using in-house staff for repairs rather than contractors is strengthened.

(4) Another aspect of current network machine operations that was outside the scope of the study was the current and projected required production of playback machines. With current annual production of approximately 48,000 machines and an average price of at least $125 per machine, this production represents a cost of at least $6,000,000 per year. Centralization of the inventory management function would improve controllability of the national supply of machines, and could potentially reduce required production of machines, other things being equal.

Regarding the feasibility and desirability of machine centralization, TMC believes that centralization is feasible, but the envisioned operating scheme is complicated, and its efficiency would be reduced, by allowing a *modus operandi* whereby network libraries would be permitted to house "depository collections" of machines. These secondary supply points would complicate the inventory management function. The only instance wherein machine depository collections are necessary, and recommended, are at the five (4 RL, 1 SRL) geographic outlier sites.

TMC concludes that NLS should at least perform an implementation study for machine centralization, despite some of the complications cited in this report. In all likelihood, the repair function will probably eventually have to be centralized, and because the inventory of machines needing repair accounts for half of on-hand inventory, the logical extrapolation of this is to also house the machines available for assignment in centralized locations as well, where the occupancy costs are dramatically lower than in network libraries. An additional reason for centralization of machine operations is that the free library program is a *national* program, the quality of machine services currently varies considerably among network sites, and a centralization scheme would result in a more uniform quality of service being offered to patrons.

APPENDICES

Appendix 1

BASELINE NETWORK COSTS

Libraries and Agencies

Cost Category	Braille Books	Playback Machines	Recorded Books	Supplies	Total Cost
Labor	$1,372,149	$5,014,594	$16,080,128	----	$22,466,871
Occupancy	1,384,705	1,350,764	8,588,514	----	11,323,983
All Other	397,201	1,358,216	5,512,136	----	7,267,553
Total Cost	$3,154,055	$7,723,574	$30,180,778	----	$41,058,408

Multistate Centers

Labor	$89,043	$45,067	$234,153	$81,397	$449,660
Occupancy	63,021	38,654	95,980	57,424	255,079
All Other	20,662	8,564	56,835	14,493	100,554
Total Cost	$172,725	$92,285	$386,969	$153,314	$805,293

Total: Libraries, Agencies & MSCs

Labor	$1,461,191	$5,059,661	$16,314,281	$81,397	$22,916,531
Occupancy	1,447,726	1,389,418	8,684,494	57,424	11,579,062
All Other	417,863	1,366,780	5,568,972	14,493	7,368,108
Total Cost	$3,326,781	$7,815,859	$30,567,747	$153,314	$41,863,701

Appendix 2

15-YEAR COST PROJECTION
MACHINES

Total: Libraries, Agencies, & MSCs

Year	Labor	Occupancy	All Other	Total Cost
Current	$5,059,661	$1,389,418	$1,366,780	$7,815,859
1	5,341,485	1,466,809	1,442,909	8,251,202
2	5,639,005	1,548,510	1,523,279	8,710,794
3	5,953,098	1,634,762	1,608,126	9,195,986
4	6,284,685	1,725,818	1,697,699	9,708,202
5	6,634,742	1,821,946	1,792,260	10,248,949
6	7,004,297	1,923,428	1,892,089	10,819,815
7	7,394,437	2,030,563	1,997,479	11,422,479
8	7,806,307	2,143,666	2,108,738	12,058,711
9	8,241,118	2,263,068	2,226,195	12,730,381
10	8,700,149	2,389,121	2,350,194	13,439,463
11	9,184,747	2,522,195	2,481,100	14,188,042
12	9,696,337	2,662,681	2,619,297	14,978,316
13	10,236,423	2,810,992	2,765,192	15,812,608
14	10,806,592	2,967,565	2,919,213	16,693,370
15	11,408,519	3,132,858	3,081,813	17,623,191
Total Cost	$125,391,603	$34,433,400	$33,872,364	$193,697,367

Appendix 3

NETWORK PROFILE MAP

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● - RL/MLA Only; ▲ - BMC/ASF Only; ■ - RL/MLA and BMC/ASF

Appendix 4

NETWORK DEMAND PROFILE

STATE	CITY	X	Y	TOTAL RECORDED BOOK READERSHIP
ALABAMA	MONTGOMERY	29.3	9.7	8,580
ARIZONA	PHOENIX	9.1	10.3	14,180
ARKANSAS	LITTLE ROCK	24.5	11.3	6,760
CALIFORNIA	LOS ANGELES	4.3	11.8	28,250
CALIFORNIA	SACRAMENTO	2.7	16.6	23,880
COLORADO	DENVER	14.8	15.9	17,830
CONNECTICUT	HARTFORD	37.5	20.8	11,410
DELAWARE	DOVER	36.0	17.8	1,880
FLORIDA	DAYTONA BEACH	34.0	7.5	50,700
GEORGIA	ATLANTA	30.7	11.2	19,770
IDAHO	BOISE	7.7	20.4	2,960
ILLINOIS	CHICAGO	27.0	18.4	34,580
INDIANA	INDIANAPOLIS	28.3	16.7	15,720
IOWA	DES MOINES	22.8	17.8	11,210
KANSAS	EMPORIA	21.3	14.6	12,400
KENTUCKY	FRANKFORT	29.6	15.3	7,860
LOUISIANA	BATON ROUGE	25.7	7.4	5,560
MAINE	AUGUSTA	38.4	23.8	4,210
MARYLAND	BALTIMORE	35.2	17.9	8,040
MASSACHUSETTS	WATERTOWN	37.8	21.6	26,150
MICHIGAN	LANSING	29.1	19.7	25,130
MICHIGAN	WAYNE	30.0	19.6	5,670
MINNESOTA	FARIBAULT	23.0	20.3	9,200
MISSISSIPPI	JACKSON	26.3	9.2	3,490
MISSOURI	JEFFERSON CITY	24.2	14.8	15,940
MONTANA	HELENA	10.8	22.8	3,260
NEBRASKA	LINCOLN	20.7	16.9	4,750
NEVADA	CARSON CITY	4.2	16.8	2,160
NEW HAMPSHIRE	CONCORD	37.7	22.4	2,770
NEW JERSEY	TRENTON	36.4	19.1	12,220
NEW MEXICO	SANTA FE	14.1	12.1	3,690
NEW YORK	ALBANY	36.4	21.3	23,970
NEW YORK	NEW YORK CITY	36.8	19.7	31,710
NORTH CAROLINA	RALEIGH	34.6	14.1	10,370
NORTH DAKOTA	GRAND FORKS	20.2	23.6	4,000
OHIO	CINCINNATI	29.7	16.3	10,490
OHIO	CLEVELAND	31.3	19.0	23,350
OKLAHOMA	OKLAHOMA CITY	20.3	11.8	7,100
OREGON	SALEM	3.1	22.5	9,710
PENNSYLVANIA	PHILADELPHIA	36.1	18.8	19,280
PENNSYLVANIA	PITTSBURGH	32.7	18.3	13,800

Appendix 4

NETWORK DEMAND PROFILE
(Continued)

STATE	CITY	X	Y	TOTAL RECORDED BOOK READERSHIP
RHODE ISLAND	PROVIDENCE	38.1	21.1	1,900
SOUTH CAROLINA	COLUMBIA	33.1	12.0	11,380
SOUTH DAKOTA	PIERRE	18.2	20.3	5,540
TENNESSEE	NASHVILLE	28.4	13.2	6,000
TEXAS	AUSTIN	20.4	6.8	37,790
UTAH	SALT LAKE CITY	10.1	17.3	5,530
VERMONT	MONTPILIER	36.7	23.1	2,020
VIRGINIA	RICHMOND	35.0	16.0	11,330
WASHINGTON	SEATTLE	4.6	24.8	12,330
WASHINGTON DC	WASHINGTON DC	35.1	17.4	3,200
WEST VIRGINIA	CHARLESTON	31.9	16.0	6,140
WISCONSIN	MILWAUKEE	26.6	19.7	9,570
WYOMING	CHEYENNE	15.1	17.2	1,440
TOTAL READERSHIP,CONTINENTAL UNITED STATES				668,160
ALASKA	ANCHORAGE			980
HAWAII	HONOLULU			1,280
PUERTO RICO	SAN JUAN			1,560
VIRGIN ISLANDS	ST. CROIX			560
TOTAL READERSHIP, GEOGRAPHIC OUTLIERS				4,380
TOTAL READERSHIP, UNITED STATES				672,540

Appendix 5

NETWORK OF UNITED STATES POSTAL SERVICE BULK MAIL FACILITIES

NO.	CITY	STATE	X	Y	FACILITY TYPE (1)
1	PHOENIX	ARIZONA	9.1	10.3	ASF
2	LOS ANGELES	CALIFORNIA	4.3	11.8	BMC
3	SAN FRANCISCO	CALIFORNIA	1.9	15.8	BMC
4	DENVER	COLORADO	14.8	15.9	BMC
5	WASHINGTON	D.C.	35.1	17.4	BMC
6	JACKSONVILLE	FLORIDA	33.3	8.4	BMC
7	ATLANTA	GEORGIA	30.7	11.2	BMC
8	CHICAGO	ILLINOIS	27.0	18.4	BMC
9	DES MOINES	IOWA	22.8	17.8	BMC
10	KANSAS CITY	KANSAS	22.3	15.3	BMC
11	SPRINGFIELD	MASSACHUSETTS	37.6	21.2	BMC
12	DETROIT	MICHIGAN	30.0	19.6	BMC
13	MINNEAPOLIS	MINNESOTA	23.0	21.0	BMC
14	ST.LOUIS	MISSOURI	25.5	15.2	BMC
15	BILLINGS	MONTANA	12.8	21.7	ASF
16	JERSEY CITY	NEW JERSEY	36.8	19.7	BMC
17	ALBUQUERQUE	NEW MEXICO	13.6	11.6	ASF
18	BUFFALO	NEW YORK	32.9	20.7	ASF
19	GREENSBORO	NORTH CAROLINA	33.7	14.2	BMC
20	FARGO	NORTH DAKOTA	20.5	22.6	ASF
21	CINCINNATI	OHIO	29.7	16.3	BMC
22	OKLAHOMA CITY	OKLAHOMA	20.3	11.8	ASF
23	PHILADELPHIA	PENNSYLVANIA	36.1	18.8	BMC
24	PITTSBURGH	PENNSYLVANIA	32.7	18.3	BMC
25	SIOUX FALLS	SOUTH DAKOTA	20.7	19.6	ASF
26	MEMPHIS	TENNESSEE	26.1	11.9	BMC
27	DALLAS	TEXAS	21.1	9.3	BMC
28	SALT LAKE CITY	UTAH	10.1	17.3	ASF
29	SEATTLE	WASHINGTON	4.6	24.8	BMC

(1) BMC - BULK MAIL CENTER
ASF - AUXILIARY SERVICE FACILITY

Appendix 6

UNITED STATES POSTAL SERVICE

SERVICE STANDARDS

(ZIP CODED MAIL ONLY)

EFFECTIVE 5/15/85

	OVERNIGHT	OVERNIGHT REQUIREMENTS	2nd DAY	3rd DAY	4th DAY	5th DAY	6th DAY	7th DAY	8th DAY	9th DAY	10th DAY
EXPRESS MAIL NEXT DAY SERVICE	OVERNIGHT NATIONWIDE[1]		(SEE DIRECTORY)								
FIRST CLASS	LOCALLY DESIGNATED CITIES AND SCF's	UP TO AND INCLUDING 5:00 P.M. COLLECTIONS	LOCALLY DESIGNATED STATES	REMAINING OUTLYING AREAS							
PRIORITY MAIL	DESIGNATED CITIES	STATED AT MAILING POST OFFICE	NATIONWIDE								
SURFACE PREFERENTIAL*	UP TO 150 MILES	5:00 P.M. MAILINGS	300 MILES — Zone 3	600 MILES — Zone 4	1,000 MILES — Zone 5	1,400 MILES — Zone 6	1,800 MILES — Zone 7	OVER 1,800 MILES — Zone 8			
BULK BUSINESS MAIL	AS DEVELOPED LOCALLY	—	INTRA-SCF (for 5:00 P.M. CARRIER PRESORTED MAILINGS)	DESIGNATED SCF's AND NON-PRESORTED INTRA-SCF	UP TO 150 MILES — Zone 2	300 MILES — Zone 3	600 MILES — Zone 4	1,000 MILES — Zone 5	1,400 MILES — Zone 6	1,800 MILES — Zone 7	OVER 1,800 MILES — Zone 8
PARCEL POST	SEE SEPARATE STANDARDS ISSUED FOR EACH BULK MAIL CENTER. This form is available at local Post Office.										

*Includes 2nd class, special handling parcel post and special delivery.

SERVICE STANDARDS

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Appendix 7

DELIVERY TIME ESTIMATION EQUATION

ACTUAL DAYS	ACTUAL MILES	ESTIMATED DAYS
2	0	3.29
4	150	3.81
5	300	4.32
6	600	5.34
7	1000	6.71
8	1400	8.08
9	1800	9.45

Regression Output:

Constant	3.293157
Std Err of Y Est	0.760630
R Squared	0.917010
No. of Observations	7
Degrees of Freedom	5
X Coefficient(s)	0.003418
Std Err of Coef.	0.000459

Regression Equation:

$Y = 3.293157 + 0.003418\ X$
Where Y = Delivery Days
and X = Miles From Origin BMC/ASF

Appendix 8

CENTROID OF MACHINE USERS AND POINT OF MINIMUM DELIVERY TIME

M = Machine User Centroid

M' - Point of Minimum Machine Delivery Time

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Appendix 9

LOCATIONS AND DELIVERY TIMES FOR 1-CENTER OPERATIONS

Description	City	State	X	Y	Average Delivery Days	Maximum Delivery Days
Machine User Centroid	South-Central	Illinois	26.0	15.9	6.3	10.2
Minimum Delivery Time, Machines	South-Central	Indiana	28.5	16.6	6.2	10.9
Postal Bulk Mail Facility	Cincinnati	Ohio	29.7	16.3	6.2	11.2
Postal Bulk Mail Facility	St. Louis	Missouri	25.5	15.2	6.3	10.1
Postal Bulk Mail Facility	Chicago	Illinois	27.0	18.4	6.2	10.4
Postal Bulk Mail Facility	Detroit	Michigan	30.0	19.6	6.3	11.3
Postal Bulk Mail Facility	Pittsburgh	Pennsylvania	32.7	18.3	6.4	12.0
Postal Bulk Mail Facility	Greensboro	N. Carolina	33.7	14.2	6.6	12.5
Postal Bulk Mail Facility	Atlanta	Georgia	30.7	11.2	6.6	12.0
Postal Bulk Mail Facility	Memphis	Tennessee	26.1	11.9	6.5	10.6
Postal Bulk Mail Facility	Kansas City	Kansas	22.3	15.3	6.6	9.2
Postal Bulk Mail Facility	Des Moines	Iowa	22.8	17.8	6.6	9.2
Postal Bulk Mail Facility	Seattle	Washington	4.6	24.8	10.4	13.2
Postal Bulk Mail Facility	Jacksonville	Florida	33.3	8.4	7.2	13.0

Appendix 10

LOCATIONS AND DELIVERY TIMES FOR 2-CENTER OPERATIONS

Location of Centers	Average Delivery Days	Readership (West)	Percent of Readership (West)	Average Delivery Days (West)	Maximum Delivery Days (West)	Readership (East)	Percent of Readership (East)	Average Delivery Days (East)	Maximum Delivery Days (East)
Salt Lake City*/Cincinnati	5.5	245,470	36.7%	6.3	8.7	422,690	63.3%	5.0	6.6
Salt Lake City/Cincinnati*	5.3	196,800	29.5%	5.9	7.6	471,360	70.5%	5.1	6.6
Salt Lake City*/Pittsburgh	5.4	245,470	36.7%	6.2	8.7	422,690	63.3%	4.9	6.5
Salt Lake City/Pittsburgh*	5.3	196,800	29.5%	5.9	7.6	471,360	70.5%	5.0	7.1
Denver*/Cincinnati	5.4	245,470	36.7%	6.0	7.3	422,690	63.3%	5.0	6.6
Denver/Cincinnati*	5.3	196,800	29.5%	5.9	7.2	471,360	70.5%	5.1	6.6
Denver*/Pittsburgh	5.3	245,470	36.7%	6.0	7.3	422,690	63.3%	4.9	6.5
Denver/Pittsburgh*	5.3	196,800	29.5%	5.9	7.2	471,360	70.5%	5.0	7.1
Denver/Washington DC**	5.5	331,270	49.6%	6.3	7.9	336,890	50.4%	4.7	6.2

*-Center that Services Minnesota, Iowa, Missouri, Arkansas and Louisiana.
**-Equal Workload Scenario.

Appendix 11

TWO CENTRAL DISTRIBUTION CENTERS
MINIMUM DELIVERY TIME SCENARIOS

Appendix 12

TWO CENTRAL DISTRIBUTION CENTERS
EQUAL WORKLOAD SCENARIO

M - Machine User Centroid

Appendix 13

TWO CENTER SCENARIO
EQUAL WORKLOAD

Region	Operation	City	Readership	%	Average Delivery Days	Maximum Delivery Days
West	Machines	Centroid	331,270	49.6	6.1	8.1
West	Machines	Salt Lake City, UT	331,270	49.6	6.8	9.3
West	Machines	Denver, CO	331,270	49.6	6.3	7.9
West	Machines	Albuquerque, NM	331,270	49.6	6.5	8.1
West	Machines	Oklahoma City, OK	331,270	49.6	6.2	9.2
West	Machines	Kansas City, KS	331,270	49.6	6.1	9.2
West	Machines	Des Moines, IA	331,270	49.6	6.2	9.2
East	Machines	Centroid	336,890	50.4	4.8	6.0
East	Machines	Cincinnati, OH	336,890	50.4	5.2	6.6
East	Machines	Pittsburgh, PA	336,890	50.4	4.8	6.5
East	Machines	Washington, DC	336,890	50.4	4.7	6.2
East	Machines	Greensboro, NC	336,890	50.4	5.0	6.4
East	Machines	Philadelphia, PA	336,890	50.4	4.8	6.6

Appendix 14

AVERAGE ANNUAL PAY BY SELECTED METROPOLITAN AREAS(1)

CITY/STATE	PAY (1987) AVERAGE ANNUAL	PERCENT OF AVERAGE
DES MOINES, IA	N/A(2)	N/A
BILLINGS, MT	N/A	N/A
FARGO, ND	N/A	N/A
ALBUQUERQUE, NM	N/A	N/A
SIOUX FALLS, SD	N/A	N/A
SALT LAKE, UT	**$18,856**	**85.5%**
JACKSONVILLE, FL	$19,141	86.8%
GREENSBORO, NC	$19,150	86.9%
BUFFALO, NY	$19,404	88.0%
OKLAHOMA CITY, OK	$19,534	88.6%
MEMPHIS, TN	$19,709	89.4%
PHOENIX, AZ	$20,612	93.5%
KANSAS CITY, MO	$20,848	94.6%
PITTSBURGH, PA	**$20,949**	**95.0%**
CINCINNATI, OH	**$21,142**	**95.9%**
ST LOUIS, MO	$21,793	98.9%
SEATTLE, WA	$21,863	99.2%
MINNEAPOLIS, MN	$22,385	101.5%
ATLANTA, GA	$22,426	101.7%
PHILADELPHIA, PA	$22,530	102.2%
DENVER, CO	**$22,649**	**102.7%**
DALLAS, TX	$22,768	103.3%
CHICAGO, IL	$23,481	106.5%
LOS ANGELES, CA	$23,921	108.5%
SPRINGFIELD, MA(3)	$24,151	109.6%
DETROIT, MI	$25,178	114.2%
WASHINGTON, DC	**$25,210**	**114.4%**
SAN FRANCISCO, CA	$25,375	115.1%
JERSEY CITY, NJ	$25,976	117.8%
Average of 24 Known Areas	$22,044	100.0%

(1) - SOURCE, U.S. BUREAU OF LABOR STATISTICS.
(2) - NOT AVAILABLE.
(3) - DATA FOR HARTFORD, CT METROPOLITAN AREA.

Appendix 15

PREVAILING RATES FOR WAREHOUSE SPACE IN SELECTED CITIES AS OF JULY 1, 1990(1)

STATE	CITY	AVERAGE RATE	PERCENT OF AVERAGE
CA	LOS ANGELES	$10.45	196.3
AZ	PHOENIX	$8.28	155.6
FL	JACKSONVILLE	$8.12	152.6
NJ	JERSEY CITY	$6.69	125.7
DC	WASHINGTON	$6.41	120.4
PA	PITTSBURGH	$6.17	115.9
WA	SEATTLE	$6.06	113.9
NC	GREENSBORO	$6.03	113.3
GA	ATLANTA	$5.65	106.2
SD	SIOUX FALLS	$5.57	104.7
PA	PHILADELPHIA	$5.50	103.3
NM	ALBUQUERQUE	$5.11	96.0
TN	MEMPHIS	$4.96	93.2
IA	DES MOINES	$4.95	93.0
IL	CHICAGO	$4.73	88.9
MT	BILLINGS	$4.46	83.8
CO	DENVER	$4.41	82.9
MI	DETROIT	$3.98	74.8
OH	CINCINNATI	$3.97	74.6
MO	ST LOUIS	$3.89	73.1
OK	OKLAHOMA CITY	$3.71	69.7
UT	SALT LAKE CITY	$3.46	65.0
TX	DALLAS	$2.97	55.8
KS	KANSAS CITY	$2.21	41.5
MA	SPRINGFIELD	N/A(2)	N/A(2)
CA	SAN FRANCISCO	N/A(2)	N/A(2)
MN	MINNEAPOLIS	N/A(2)	N/A(2)
ND	FARGO	N/A(2)	N/A(2)
NY	BUFFALO	N/A(2)	N/A(2)
AVERAGE RATE FOR 24 KNOWN CITIES		$5.32	100.0%

(1) - SOURCE, U.S. GENERAL SERVICES ADMINISTRATION.
(2) - NOT AVAILABLE.

Appendix 16

NETWORK RECORDED BOOK READERSHIP PROFILE

State	City	Individual Disc Reader-ship	Individual Cassette Reader-ship	Deposit Collection Disc Reader-ship	Deposit Collection Cassette Reader-ship	Disc Total Reader-ship(1)	Cassette Total Reader-ship(1)	Grand Total Reader-ship
WESTERN CENTER								
ALASKA	Anchorage	210	490	20	50	290	690	980
ARIZONA	Phoenix	2,700	7,440	310	700	3,940	10,240	14,180
ARKANSAS	Little Rock	1,810	3,590	130	210	2,330	4,430	6,760
CALIFORNIA	Los Angeles	7,560	17,850	220	490	8,440	19,810	28,250
CALIFORNIA	Sacramento	6,710	13,210	280	710	7,830	16,050	23,880
COLORADO	Denver	5,280	8,070	430	690	7,000	10,830	17,830
HAWAII	Honolulu	450	830	—	—	450	830	1,280
IDAHO	Boise	750	1,930	30	40	870	2,090	2,960
IOWA	Des Moines	3,750	4,420	370	390	5,230	5,980	11,210
KANSAS	Emporia	2,730	5,910	380	560	4,250	8,150	12,400
LOUISIANA	Baton Rouge	1,620	2,980	120	120	2,100	3,460	5,560
MINNESOTA	Faribault	2,180	5,580	120	240	2,660	6,540	9,200
MISSOURI	Jefferson City	4,790	7,950	330	470	6,110	9,830	15,940
MONTANA	Helena	680	2,060	40	90	840	2,420	3,260
NEBRASKA	Lincoln	930	2,420	110	240	1,370	3,380	4,750
NEVADA	Carson City	730	1,230	10	40	770	1,390	2,160
NEW MEXICO	Santa Fe	850	1,840	90	160	1,210	2,480	3,690
NORTH DAKOTA	Grand Forks	1,260	2,060	40	130	1,420	2,580	4,000
OKLAHOMA	Oklahoma City	1,930	3,890	110	210	2,370	4,730	7,100
OREGON	Salem	3,280	5,270	110	180	3,720	5,990	9,710
SOUTH DAKOTA	Pierre	1,620	2,400	130	250	2,140	3,400	5,540
TEXAS	Austin	9,660	18,450	710	1,710	12,500	25,290	37,790
UTAH	Salt Lake City	1,370	3,480	50	120	1,570	3,960	5,530
WASHINGTON	Seattle	4,520	6,650	120	170	5,000	7,330	12,330
WYOMING	Cheyenne	400	760	30	40	520	920	1,440
EASTERN CENTER								
ALABAMA	Montgomery	2,500	4,680	120	230	2,980	5,600	8,580
CONNECTICUT	Rocky Hill	3,800	5,450	300	240	5,000	6,410	11,410
DELAWARE	Dover	610	990	30	40	730	1,150	1,880
DIST OF COL.	Washington	1,200	1,680	30	50	1,320	1,880	3,200
FLORIDA	Daytona Beach	18,130	25,410	860	930	21,570	29,130	50,700
GEORGIA	Atlanta	3,810	9,000	720	1,020	6,690	13,080	19,770
ILLINOIS	Chicago	8,230	16,350	840	1,660	11,590	22,990	34,580
INDIANA	Indianapolis	4,430	6,690	500	650	6,430	9,290	15,720
KENTUCKY	Frankfort	2,010	4,290	120	270	2,490	5,370	7,860
MAINE	Augusta	2,640	1,170	20	80	2,720	1,490	4,210
MARYLAND	Baltimore	2,440	4,240	150	190	3,040	5,000	8,040
MASSACHUSETTS	Watertown	7,790	11,600	750	940	10,790	15,360	26,150
MICHIGAN	Wayne	1,870	2,400	190	160	2,630	3,040	5,670
MICHIGAN	Lansing	6,680	12,490	540	950	8,840	16,290	25,130
MISSISSIPPI	Jackson	830	1,860	70	130	1,110	2,380	3,490
NEW HAMPSHIRE	Concord	880	1,490	70	30	1,160	1,610	2,770
NEW JERSEY	Trenton	3,790	8,350	10	10	3,830	8,390	12,220
NEW YORK	New York	12,880	16,230	1,300	1,300	14,180	17,530	31,710
NEW YORK	Albany	6,530	14,310	1,320	1,810	7,850	16,120	23,970
NORTH CAROLINA	Raleigh	2,670	5,860	190	270	3,430	6,940	10,370
OHIO	Cleveland	8,000	9,830	700	680	10,800	12,550	23,350
OHIO	Cincinnati	3,240	4,530	340	340	4,600	5,890	10,490
PENNSYLVANIA	Pittsburgh	4,540	7,300	230	260	5,460	8,340	13,800

Appendix 16

NETWORK RECORDED BOOK READERSHIP PROFILE
(Continued)

State	City	Individual Disc Reader-ship	Individual Cassette Reader-ship	Deposit Collection Disc Reader-ship	Deposit Collection Cassette Reader-ship	Disc Total Reader-ship(1)	Cassette Total Reader-ship(1)	Grand Total Reader-ship
PENNSYLVANIA	Philadelphia	6,920	9,200	400	390	8,520	10,760	19,280
PUERTO RICO	San Juan	640	680	30	30	760	800	1,560
RHODE ISLAND	Providence	410	1,370	10	20	450	1,450	1,900
SOUTH CAROLINA	Columbia	3,530	6,450	160	190	4,170	7,210	11,380
TENNESSEE	Nashville	1,630	3,650	50	130	1,830	4,170	6,000
VERMONT	Montpelier	490	1,090	70	40	770	1,250	2,020
VIRGIN ISLANDS	St. Croix	100	140	40	40	260	300	560
VIRGINIA	Richmond	2,910	7,100	110	220	3,350	7,980	11,330
WEST VIRGINIA	Charleston	1,700	3,320	100	180	2,100	4,040	6,140
WISCONSIN	Milwaukee	3,230	6,140	20	30	3,310	6,260	9,570
TOTAL READERSHIP,EAST						164,760	260,050	424,810
PERCENT OF TOTAL READERSHIP,EAST						66.0%	61.5%	63.2%
TOTAL READERSHIP,WEST						84,930	162,800	247,730
PERCENT OF TOTAL READERSHIP,WEST						34.0%	38.5%	36.8%
GRAND TOTAL READERSHIP						249,690	422,850	672,540
PERCENT OF GRAND TOTAL READERSHIP						100.0%	100.0%	100.0%

(1) Total readership is defined as individual readers plus four times the number of deposit collections, per NLS.

Appendix 17
NETWORK MACHINE REPAIR PROFILE

STATE	REGION	TBM TP REPAIRS	TBM OTHER REPAIRS	CBM TP REPAIRS	CBM OTHER REPAIRS	TOTAL TP REPAIRS	TOTAL OTHER REPAIRS	GRAND TOTAL REPAIRS
AL	E	76	766	1,336	364	1,412	1,130	2,542
CT	E	0	492	0	2,330	0	2,822	2,822
DC	E	445	53	1,451	251	1,896	304	2,200
DE	E	82	0	261	0	343	0	343
FL	E	3,500	40	9,867	900	13,367	940	14,307
GA	E	85	361	433	2,557	518	2,918	3,436
IL	E	994	0	7,985	0	8,979	0	8,979
IN	E	851	0	2,812	0	3,663	0	3,663
KY	E	22	200	1,095	361	1,117	561	1,678
ME	E	52	58	135	333	187	391	578
MA	E	1,113	495	1,940	1,767	3,053	2,262	5,315
MD	E	308	27	891	309	1,199	336	1,535
MI	E	1,450	2,551	3,040	4,508	4,490	7,059	11,549
MI	E	0	154	0	526	0	680	680
MS	E	133	0	844	0	977	0	977
NC	E	5	798	10	2,150	15	2,948	2,963
NH	E	100	0	415	4	515	4	519
NJ	E	433	10	1,266	540	1,699	550	2,249
NY	E	480	288	480	2,400	960	2,688	3,648
NY	E	50	1,800	1,200	2,300	1,250	4,100	5,350
OH	E	464	482	3,574	1,938	4,038	2,420	6,458
PR	E	0	167	0	143	0	310	310
PA	E	560	178	2,000	2,129	2,560	2,307	4,867
PA	E	679	10	864	642	1,543	652	2,195
RI	E	131	0	373	14	504	14	518
SC	E	478	100	1,504	380	1,982	480	2,462
TN	E	75	328	1,216	458	1,291	786	2,077
VA	E	690	68	1,645	392	2,335	460	2,795
VT	E	48	0	40	30	88	30	118
VI	E	10	0	0	25	10	25	35
WV	E	0	25	169	41	169	66	235
WI	E	785	0	2,061	0	2,846	0	2,846
AK	W	0	14	0	102	0	116	116
AZ	W	503	0	3,430	0	3,933	0	3,933
AR	W	480	0	1,704	50	2,184	50	2,234
CA	W	1,184	1,038	3,342	987	4,526	2,025	6,551
CA	W	280	135	2,562	142	2,842	277	3,119
CO	W	868	0	2,923	0	3,791	0	3,791
HI	W	0	91	0	430	0	521	521
IA	W	259	82	1,062	167	1,321	249	1,570
ID	W	0	56	0	887	0	943	943
KS	W	382	82	1,768	869	2,150	951	3,101
LA	W	62	20	111	36	173	56	229
MN	W	616	0	719	1,319	1,335	1,319	2,654
MO	W	299	76	988	1,815	1,287	1,891	3,178
MT	W	128	0	654	0	782	0	782
ND	W	25	0	28	39	53	39	92
NM	W	250	0	1,961	0	2,211	0	2,211
NE	W	114	57	530	576	644	633	1,277
NV	W	155	0	490	100	645	100	745
OK	W	0	498	0	1,776	0	2,274	2,274
OR	W	271	0	750	2,080	1,021	2,080	3,101
SD	W	0	57	0	625	0	682	682
TX	W	515	0	3,913	0	4,428	0	4,428
UT	W	102	45	348	135	450	180	630
WA	W	528	0	780	370	1,308	370	1,678
WY	W	59	0	30	0	89	0	89
TOTAL EASTERN REGION		14,099	9,451	48,907	27,792	63,006	37,243	100,249
TOTAL WESTERN REGION		7,080	2,251	28,093	12,505	35,173	14,756	49,929
GRAND TOTAL, TP/NON-TP		21,179	11,702	77,000	40,297	98,179	51,999	150,178
GRAND TOTAL			32,881		117,297		150,178	

Appendix 18
NETWORK MACHINE CIRCULATION PROFILE

MACHINE CIRCULATION	WESTERN CENTER	EASTERN CENTER	TOTAL
ISSUES			
FOR NEW PATRONS	25,715	43,785	69,500
FOR REPLACEMENTS	50,662	86,262	136,924
FOR WARRANTY REPAIRS	1,110	1,890	3,000
FOR DISPOSAL	1,184	2,016	3,200
TOTAL	78,671	133,953	212,624
RECEIPTS			
PATRONS LEAVING SERVICE	19,330	32,912	52,242
DEFECTIVES RETURNED	50,662	86,262	136,924
WARRANTY REPAIR RETURNS	1,110	1,890	3,000
NEW PRODUCTION	17,760	30,240	48,000
TOTAL	88,862	151,304	240,166

Appendix 19

NETWORK MACHINE INVENTORY PROFILE

END OF SEPTEMBER, 1989

STATE	CITY	AVAILABLE TMB INVENTORY	ASSIGNED TMB INVENTORY	IN REPAIR TMB INVENTORY	AVAILABLE CBM INVENTORY	ASSIGNED CBM INVENTORY	IN REPAIR CBM INVENTORY
AK	Anchorage	63	233	9	658	547	42
AL	Montgomery	238	3495	1383	390	6188	1688
AR	Little Rock	642	2054	252	793	4352	482
AZ	Phoenix	93	2732	421	321	6961	1153
CA	Los Angeles	287	7749	447	778	18748	3046
CA	Sacramento	115	6708	27	93	14433	693
CO	Denver	96	3646	48	495	5715	251
CT	Rocky Hill	284	2268	0	615	6117	27
DC	Washington	69	2216	60	432	2527	130
DE	Dover	129	596	23	269	1133	146
FL	Daytona Beach	143	17719	21	208	33768	94
GA	Atlanta	498	5453	0	662	11387	51
HI	Honolulu	122	362	5	398	839	43
IA	Des Moines	264	4221	85	799	6162	1220
ID	Boise	771	865	1	1092	2139	61
IL	Chicago	305	8825	581	1996	17941	1813
IN	Indianapolis	176	6288	88	441	9828	553
KS	Emporia	746	3837	40	807	7214	157
KY	Frankfort	89	2734	487	307	5013	2348
LA	Baton Rouge	34	480	50	192	1975	80
MA	Cambridge	475	9033	621	569	14202	635
MD	Baltimore	178	5412	88	1331	15322	630
ME	Augusta	117	1935	233	556	1785	312
MI	Lansing	580	5745	383	2167	11363	681
MI	Wayne	32	1633	50	592	2601	242
MN	St. Paul	826	3057	526	465	8623	2484
MO	Jefferson City	374	6186	769	650	10314	2000
MS	Jackson	87	1372	437	664	3012	773
MT	Helena	250	950	7	734	2431	80
NC	Raleigh	514	5990	146	305	10176	434
ND	Grand Forks	164	615	69	283	2078	268
NE	Lincoln	439	1511	4	916	3720	41
NH	Concord	375	1357	76	570	2487	338
NJ	Trenton	163		83	541		281
NM	Santa Fe	87	1231	365	356	2813	446
NV	Carson City	68	865	41	225	1385	202
NY	Albany	286	8801	679	3134	20677	3495
NY	New York	106	10506	118	1952	19562	1501
OH	Columbus	444	10119	796	2869	20507	2212
OK	Oklahoma City	53	1832	0	252	4094	0
OR	Salem	294	2357	48	1495	6578	1161
PA	Pittsburgh	1052	3997	0	1631	6372	245
PA	Philadelphia	416	5688	125	1185	8874	527
PR	San Juan	21	599	730	48	663	431
RI	Providence	172	548	10	888	1649	84
SC	Columbia	428	3382	133	1598	6396	278
SD	Pierre	4	799	265	840	2428	733
TN	Nashville	527	5119	169	2340	7871	387
TX	Austin	436	15754	194	161	22059	2225
UT	Salt Lake City	423	2562	408	1267	4910	727
VA	Richmond	177	3798	148	253	8330	693
VI	St. Croix	210	225	7	216	264	108
VT	Montpelier	87	679	49	210	1849	231
WA	Seattle	213	4297	168	349	7444	1662
WI	Milwaukee	270	4342	212	15	7440	1767
WV	Charleston	18	2179	157	42	3621	990
WY	Cheyenne	496	628	2	251	1069	21
	TOTAL,BY SUB-INVENTORY	16,026	218,484	12,344	43,696	417,956	43,403
	PERCENT	6.5%	88.5%	5.0%	8.7%	82.8%	8.6%
	TOTAL,BY TBM/CBM			246,854			505,055
	PERCENT			32.8%			67.2%
	GRAND TOTAL						751,909

Appendix 20

AVERAGE TOTAL LABOR COST PER MACHINE AND MACHINE INVENTORY

16 REGIONAL LIBRARIES IN SAMPLE THAT ARE MLAs

SORTED ON LABOR COST PER MACHINE			SORTED ON MACHINE INVENTORY		
LABOR COST PER MACHINE	MACHINE INVENTORY	USES SUB-REGIONALS	LABOR COST PER MACHINE	MACHINE INVENTORY	USES SUB-REGIONALS
$26.18	1769	SRL	$26.18	1769	SRL
10.66	9311		4.32	2811	
9.34	16815		4.54	4938	
8.99	6231	SRL	8.99	6231	SRL
6.64	10297		10.66	9311	
5.77	20919	SRL	6.64	10297	
5.19	22069	SRL	2.38	14133	
4.96	31055		9.34	16815	
4.80	22961	SRL	2.43	18051	SRL
4.54	4938		1.93	20293	
4.32	2811		5.77	20919	SRL
4.19	40829		5.19	22069	SRL
2.43	18051	SRL	4.80	22961	SRL
2.38	14133		4.96	31055	
2.06	51953	SRL	4.19	40829	
$1.93	20293		$2.06	51953	SRL

	LABOR COST PER MACHINE
UNWEIGHTED MEAN,16 SITES	$6.52
WEIGHTED MEAN,16 SITES (*)	$4.60
MEDIAN,16 SITES	$4.88
UNWEIGHTED MEAN,NON-SRL SITES	$5.44
WEIGHTED MEAN,NON-SRL SITES (*)	$5.03
MEDIAN,NON-SRL SITES	$4.54
UNWEIGHTED MEAN,NON-SRL SITES > 10,000 MACH.	$4.91
WEIGHTED MEAN,NON-SRL SITES > 10,000 MACH. (*)	$4.67
MEDIAN,NON-SRL SITES > 10,000 MACH.	$4.58

* Weighted by Machine Inventory

Appendix 21
DETAILED TOTAL LABOR COST PROFILE OF MACHINE OPERATIONS
SAMPLE SITES

16 REGIONAL LIBRARIES				
Labor Costs: *	WEIGHTED UNIT COST(*)	WEIGHTED PERCENT(*)	UNWEIGHTED UNIT COST	UNWEIGHTED PERCENT
Set-up; maintain patron files	$0.55	12.0%	$0.91	14.0%
Check-in; shelve	$0.34	7.4%	$0.47	7.3%
Inspect books	$0.14	3.0%	$0.18	2.8%
Duplicate books	$0.00	0.0%	$0.00	0.0%
Build & maintain collection	$0.10	2.1%	$0.16	2.4%
Repair books & machines	$0.93	20.3%	$1.57	24.1%
Receive requests, make selections	$0.48	10.4%	$0.60	9.1%
Check-out; delivery	$0.43	9.4%	$0.54	8.2%
Retrieve overdue items	$0.16	3.5%	$0.39	6.0%
Manage & support operations	$1.47	31.9%	$1.70	26.1%
Total, Labor Costs	$4.60	100.0%	$6.52	100.0%
RLs WITH NO SRLs				
Labor Costs: *				
Set-up; maintain patron files	$0.51	10.1%	$0.49	8.9%
Check-in; shelve	$0.33	6.7%	$0.31	5.7%
Inspect books	$0.06	1.1%	$0.16	2.9%
Duplicate books	$0.00	0.0%	$0.00	0.0%
Build & maintain collection	$0.07	1.4%	$0.10	1.8%
Repair books & machines	$1.13	22.5%	$1.42	26.1%
Receive requests, make selections	$0.41	8.1%	$0.52	9.5%
Check-out; delivery	$0.57	11.3%	$0.54	10.0%
Retrieve overdue items	$0.18	3.5%	$0.19	3.6%
Manage & support operations	$1.78	35.3%	$1.72	31.5%
Total, Labor Costs	$5.03	100.0%	$5.44	100.0%
LARGE RLs WITH NO SRLs				
Labor Costs: *				
Set-up; maintain patron files	$0.52	11.2%	$0.43	8.7%
Check-in; shelve	$0.35	7.5%	$0.35	7.2%
Inspect books	$0.04	0.8%	$0.03	0.6%
Duplicate books	$0.00	0.0%	$0.00	0.0%
Build & maintain collection	$0.08	1.7%	$0.14	2.8%
Repair books & machines	$0.88	18.8%	$1.02	20.8%
Receive requests, make selections	$0.38	8.1%	$0.52	10.6%
Check-out; delivery	$0.58	12.3%	$0.63	12.8%
Retrieve overdue items	$0.18	3.9%	$0.23	4.7%
Manage & support operations	$1.66	35.6%	$1.56	31.7%
Total, Labor Costs	$4.67	100.0%	$4.91	100.0%

* Weighted by Machine Inventory.

Appendix 22

ESTIMATION OF LABOR COSTS FOR MACHINE OPERATIONS CENTERS AND LIBRARIES

REPAIRS PERFORMED BY IN-HOUSE STAFF

	COSTS AT CENTERS	COSTS AT LIBRARIES	TOTAL COST
Labor Costs:			
Set-up; maintain patron files	N/A	$686,700	$686,700
Check-in; shelve	$266,859	N/A	$266,859
Inspect books	WITH REPAIR	N/A	WITH REPAIR
Duplicate books	N/A	N/A	N/A
Build & maintain collection	$104,694	N/A	$104,694
Repair books & machines	$3,341,081	N/A	$3,341,081
Receive requests, make selections	N/A	$448,412	$448,412
Check-out; delivery	$472,216	N/A	$472,216
Retrieve overdue items	$174,253	N/A	$174,253
Manage & support operations	$837,464	$400,720	$1,238,184
Total, Labor Costs	$5,196,567	$1,535,832	$6,732,399
IF 10% OF CHECK-IN,CHECK-OUT AND RETRIEVE OVERDUES DONE BY RL/SRL	$5,105,234	$1,641,194	$6,746,428

REPAIRS PERFORMED BY CONTRACTOR

	COSTS AT CENTERS	COSTS AT LIBRARIES	TOTAL COST
Labor Costs:			
Set-up; maintain patron files	N/A	$686,700	$686,700
Check-in; shelve	$266,859	N/A	$266,859
Inspect books	WITH REPAIR	N/A	WITH REPAIR
Duplicate books	N/A	N/A	N/A
Build & maintain collection	$104,694	N/A	$104,694
Repair books & machines	$3,831,134	N/A	$3,831,134
Receive requests, make selections	N/A	$448,412	$448,412
Check-out; delivery	$472,216	N/A	$472,216
Retrieve overdue items	$174,253	N/A	$174,253
Manage & support operations	$837,464	$400,720	$1,238,184
Total, Labor Costs	$5,686,620	$1,535,832	$7,222,452
IF 10% OF CHECK-IN,CHECK-OUT AND RETRIEVE OVERDUES DONE BY RL/SRL	$5,588,981	$1,641,194	$7,230,175

Appendix 23

OCCUPANCY REQUIREMENTS
CENTRALIZED MACHINE OPERATIONS

Phase I Prediction Model for Machine Operations Required Facility Space:

Total Required Area (sf) = 408.3 + 0.091 x Total Machine Inventory

	Western Center	Eastern Center	Total
Total Machine Inventory	278,206	473,703	751,909
Total Area (sf)*	25,725	43,515	69,240

* Assumes that all functions would be performed at machine centers.

Appendix 24

FACILITY SPACE REQUIRED FOR MACHINE STORAGE MACRO AND PRO-FORMA ESTIMATIONS

(1) Estimation Based Upon Macro-Parameters

Total estimated space per Appendix 23 = 69,240 sf
Average percent of area used for storage = 45%
Total estimated space for storage = 31,158 sf

(2) Estimation Based Upon Pro-Forma Workload and Preferred Storage Methods

Average Machine Dimensions:

TBM - 14.5" W x 12.5" D x 8.25" H
TBM - 15.8" W x 14" D x 8" H
CBM - 9" W x 11" D x 3.5" H

Preferred Storage Methods:

TBM - Shelf racks, 4' wide sections, 18" deep shelves, 2 tiers per section, 2 sections per module, 8' high storage, 3' storage aisle width, machines stored horizontally, stacked 5 high each tier

CBM - Shelf racks, 3' (or 4') wide sections, 1' deep shelves, 8 tiers per section, 2 sections per module, 8' high storage, 3' storage aisle width, machines stored on side, stacked 1 high each tier

Required Storage Space:

TBM - 3 TBMs side by side per 4' shelf
stacked 5 high per shelf
15 TBMs per shelf
2 shelves per rack section
30 TBMs per section
2 sections per module
60 TBMs per module
246,854 TBMs total inventory
15% of inventory in-house on average
37,028 TBMs in-house storage requirement
617 modules required
24 sf per storage module [(18" + 18" + 3') x 4']
14,808 sf required, direct storage area
25% allowance for cross aisles
10% vacancy allowance and equipment accessory storage
20,361 sf required total area for TBM storage

Appendix 24

FACILITY SPACE REQUIRED FOR MACHINE STORAGE
MACRO AND PRO-FORMA ESTIMATIONS
(Continued)

CBM -

9 CBMs side by side per 3' shelf
stacked 1 high, on side, per shelf
9 CBMs per shelf
8 shelves per rack section
72 CBMs per section
2 sections per module
144 CBMs per module
505,055 CBMs total inventory
15% of inventory in-house on average
75,758 CBMs in-house storage requirement
526 required modules
15 sf per storage module [(1' + 1' + 3') x 3']
7,890 sf required, direct storage area
25% allowance for cross aisles
10% vacancy allowance and equipment accessory storage
10,849 sf required total area for CBM storage

Total Estimated Space for Storage = 20,361 sf + 10,849 sf
= 31,210 sf

Appendix 25

ESTIMATED OCCUPANCY REQUIREMENTS AND COSTS BASED ON CURRENT MACHINE INVENTORIES MACHINE CENTERS AND NETWORK LIBRARIES

Machine Centers

	Western Center	Eastern Center	Total
Storage Space (sf)	11,548	19,662	31,210
Unadjusted Non-Storage Space (sf)	14,071	23,959	38,030
Adjustment Factor	-28.3%	-28.3%	-28.3%
Non-Storage Space (sf)	10,089	17,179	27,268
Total Space (sf)	21,637	36,841	58,478
Unit Occupancy Cost	$3.46	$3.97	---
Total Occupancy Cost	$74,864	$146,259	$221,123

Network Libraries

Total Current Occupancy Costs	$1,350,764
Adjustment Factor	-68.7%
Total Occupancy Cost	$422,789
Grand Total Occupancy Costs, Centers and Libraries	$643,912